Communities, Teachers, Conservationists - Deconstruction and Reconstruction of Environmental Education in Madagascar

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Summary

Environmental education (EE) evolved as a response to increasing concerns about environmental issues and to the question of how to reach sustainability. This is especially crucial in settings where the well-being of the local population directly depends on the ecosystems and their services. In Madagascar, overexploitation and unsustainable land use practices threaten both the exceptional biodiversity and the subsistence of the rural population. While the country represents a global conservation priority, success of conservation practices remains weak. Global policy frameworks suggest that EE is key in solving these issues and is critical in developing an informed population who will (be able to) contribute to sustainable development.

This thesis was realized in the realms of the AMBio project 'Alaotra Marshland Biodiversity – strategies for the conservation of biodiversity in Madagascar using the example of Lake Alaotra'. It takes an interdisciplinary mixed-methods approach to investigate the potential of EE in contributing to conservation at Lake Alaotra and beyond. Madagascar is one of the poorest countries globally, and its education system proves to be weak. Non-governmental organizations are implementing EE programs, largely aiming to foster pro-environmental attitudes and to halt environmental destruction. To increase the potential impact of EE, it has been repeatedly suggested to integrate EE into formal schooling.

Understanding people's attitudes and perceptions of the environment is crucial, both for conservation success and for drafting appropriate and efficient educational interventions. This thesis thus examines in a first part knowledge, attitudes and perceptions of natural resource users toward environmental values of Lake Alaotra. The surveys suggest that conservation is largely accepted as long as it is not threatening livelihood. In a second part, prospects to implement EE in public primary schools are assessed, including school structure, as well as teachers' capacities and perceptions. Results suggest that the education system generally struggles to provide quality education, and that the implementation of EE as envisioned by UNESCO is facing substantial barriers. In a third part, significant life experiences of active conservationists are examined to identify promising approaches that could help to develop a citizenry in Madagascar that is

aware about environmental issues and capable of actively contributing to their solutions. The results indicate the transformative potential of excursions and contact with inspiring educators, which were enabled through higher education.

The evidence collected and collated in this applied and transdisciplinary research suggests that EE may well support a negotiation between conservation and development, but that high transaction costs are required to reach a level of EE teaching and learning that can foster critical thinking and capacity building. However, without such a transformative education, the role of EE for conservation and development risks to fail. It is the recent political decisions that raise hope that EE can finally embark on the responsible journey to enhance the educational system and to contribute to a reconciliation of conservation and sustainable development. This thesis offers insights into local realities, and relevant fields of capacity building to ensure that these political decisions will not remain a theoretical construct, but will be implemented and thus increase success in biodiversity conservation and sustainable development.

Zusammenfassung

Das Konzept der Umweltbildung entstand aufgrund zunehmender Beunruhigung bezüglich existierender Umweltprobleme und mit dem Ziel für mehr Nachhaltigkeit. Insbesondere in Situationen, in welchen das Wohlergehen der lokalen Bevölkerung direkt von Ökosystemen und deren Dienstleistungen abhängt, ist dies von großer Wichtigkeit. In Madagaskar bedrohen Übernutzung und nicht nachhaltige Landnutzungspraktiken sowohl die außergewöhnliche Biodiversität, als auch die Existenz der ruralen Bevölkerung. Während das Land weltweit eine der höchsten Naturschutz-Prioritäten darstellt, bleibt der Erfolg in der Praxis begrenzt. Globale Handlungsempfehlungen bezeichnen Umweltbildung als Schlüssel für die Lösung solcher Probleme, und als entscheidend für die Entfaltung einer informierten Bevölkerung, welche in der Lage sein wird, zu einer nachhaltigen Entwicklung beizutragen.

Diese Dissertation wurde im Rahmen des AMBio-Projekts "Alaotra Marshland Biodiversity - Strategien zum Erhalt der Biodiversität in Madagaskar am Beispiel des Alaotra-Sees" erstellt. Sie nutzt einen interdisziplinären Mixed-Method-Ansatz, um das Potenzial von Umweltbildung zu untersuchen, zu Naturschutz am Alaotra-See und darüber hinaus beizutragen. Madagaskar ist weltweit eines der ärmsten Länder mit einem schwachen Bildungssystem. Nichtregierungs-Organisationen verwirklichen unter anderem Umweltbildungsprogramme, die weitgehend darauf abzielen, das Umweltbewusstsein zu stärken und Umwelt-zerstörung aufzuhalten. Um den potenziellen Nutzen von Umweltbildung zu erhöhen, wurde wiederholt vorgeschlagen, diese in die formale Schulbildung zu integrieren.

Es ist sowohl für den Erfolg von Naturschutz, als auch für die Konzipierung adäquater und wirkungsvoller Bildungsinterventionen von entscheidender Bedeutung, die Einstellungen der Bevölkerung zu verstehen. Diese Dissertation untersucht daher in einem ersten Teil das Wissen, die Einstellung und die Wahrnehmungen natürlicher Ressourcennutzer in Bezug auf Umwelt-Werte des Alaotra-Sees. Die Erhebungen deuten darauf hin, dass Naturschutz weitgehend akzeptiert wird, solange dies nicht den Lebensunterhalt gefährdet. In einem zweiten Teil werden die Möglichkeiten und Erfolgsaussichten zur Umsetzung von

Umweltbildung in öffentlichen Grundschulen untersucht, einschließlich der Schulstruktur, sowie Kapazitäten und Einstellung der Lehrkräfte. Die Ergebnisse zeigen auf, dass das Bildungssystem im Allgemeinen damit kämpft, eine qualitativ hochwertige Ausbildung zu bieten, und dass die Umsetzung der Umweltbildung wie sie von der UNESCO vorgesehen ist mit erheblichen Hemmnissen konfrontiert ist. In einem dritten Teil werden wesentliche Lebenserfahrungen aktiver Naturschützer untersucht um zu ermitteln welche Ansätze dazu beitragen könnten, eine Bevölkerung in Madagaskar hervorzubringen, welche sich der Umweltprobleme bewusst ist und kompetent ist, aktiv zu deren Lösung beizutragen. Die Ergebnisse legen nahe, dass Exkursionen und Kontakt mit inspirierenden ‚Lehrern' im Rahmen der Hochschulbildung großes transformatives Potenzial bieten.

Die Ergebnisse welche im Rahmen dieser angewandten und transdisziplinären Forschung erhoben und zusammengeführt wurden deuten darauf hin, dass Umweltbildung durchaus eine Vermittlerposition zwischen Naturschutz und Entwicklung einnehmen könnte, allerdings ist ein hoher Aufwand erforderlich, um ein Niveau von Umweltbildung zu erreichen, welches kritisches Denken und Handlungskompetenzen fördert. Ohne solch eine transformative Bildung wird das Potenzial der Umweltbildung für den Naturschutz und die Entwicklung riskiert. Die jüngsten politischen Entscheidungen geben Hoffnung, dass Umweltbildung letztlich auf die verantwortungsvolle Reise zur Unterstützung des Bildungssystems gehen kann, und zu einer Versöhnung von Naturschutz und nachhaltiger Entwicklung beitragen kann. Die vorliegende Dissertation bietet Einblicke in die lokalen Realitäten und relevante Bereiche des ‚Kapazitätsaufbaus', welcher nötig ist damit diese politischen Entscheidungen nicht Theorie bleiben, sondern Umsetzung finden, und damit die Erfolge im Biodiversitätserhalt und der nachhaltigen Entwicklung erhöhen.

Résumé

L'éducation environnementale (EE) a évolué comme une réponse aux préoccupations croissantes concernant les problèmes environnementaux ainsi qu'à la question de savoir comment atteindre le développement durable. Dans les milieux où le bien-être de la population locale dépend directement des écosystèmes et de leurs services, ce concept s'avère crucial. La surexploitation du territoire et les pratiques non-durables menacent à la fois l'exceptionnelle biodiversité et la subsistance de la population rurale de Madagascar. Bien que le pays fasse partie des priorités mondiales principales en matière de conservation, le taux de succès demeure faible. Les politiques mondiales suggèrent que l'EE est essentielle pour résoudre ces problèmes et pour assurer le développement d'une population informée qui contribuera (ou pourra contribuer) au développement durable.

Cette thèse a été réalisée dans le cadre du projet AMBio „Alaotra Marshland Biodiversity - stratégies pour la conservation de la biodiversité à Madagascar en utilisant l'exemple du Lac Alaotra". L'étude du potentiel de l'EE à contribuer à la conservation au lac Alaotra et au-delà nécessite l'utilisation d'une approche interdisciplinaire mixte. Madagascar est l'un des pays les plus pauvres à l'échelle mondiale et son système éducatif s'avère faible. Certaines organisations non-gouvernementales (ONGs) mettent en œuvre des programmes d'EE qui visent en grande partie à promouvoir des attitudes pro-environnementales et à freiner la destruction de l'environnement. Pour augmenter le potentiel impact de l'EE, il a été suggéré à maintes reprises d'intégrer l'EE dans la scolarité normale.

Comprendre les attitudes et les perceptions environnementales des populations locales est crucial à la fois pour la réussite de la conservation, et pour la création d'interventions éducatives appropriées et efficaces. Cette thèse examine donc dans une première partie les connaissances, attitudes et perceptions des utilisateurs des ressources naturelles du lac Alaotra face aux valeurs environnementales. Les enquêtes suggèrent que la conservation est largement acceptée tant qu'elle ne menace pas les moyens de subsistance. Dans une deuxième partie, les perspectives d'implémentation de l'EE dans les écoles primaires publiques sont évaluées, y compris au niveau de la structure scolaire,

ainsi que les capacités et les perceptions des enseignants. Les résultats suggèrent que le système éducatif rencontre des difficultés pour fournir une éducation de qualité et que la mise en œuvre de l'EE comme envisagée par l'UNESCO doit faire face à des obstacles conséquents. Dans une troisième partie, des expériences pertinentes, basées sur la vie de conservationistes en activité, sont examinées afin d'identifier des approches prometteuses qui pourraient aider à développer, à Madagascar, une population ayant connaissance des problèmes environnementaux et en capacité de contribuer activement à les résoudre. Les résultats indiquent le potentiel de transformation que représentent les excursions sur sites et le contact avec des éducateurs issus de l'éducation supérieure et source d'inspiration.

Les preuves collectées et rassemblées dans cette recherche appliquée et transdisciplinaire suggèrent que l'EE pourrait aider à la négociation entre conservation et développement, mais que des coûts de transaction élevés sont nécessaires pour atteindre un niveau d'enseignement et d'apprentissage de l'EE qui favoriserait la pensée critique et le renforcement des capabilités. Cependant, sans un tel apprentissage transformateur, le rôle de l'EE dans la conservation et le développement risque l'échec. De récentes décisions politiques donnent cependant espoir que l'EE puisse finalement entreprendre un voyage responsable afin d'améliorer le système éducatif qui contribuera à une réconciliation entre conservation et développement durable. Cette thèse offre un aperçu des réalités locales et de certains domaines pertinents du renforcement des capacités, afin de s'assurer que ces décisions politiques ne resteront pas théoriques, mais qu'elles trouveront bien une mise en œuvre et ainsi augmenteront le taux de succès dans les domaines de la conservation de la biodiversité et du développement durable.

Famintinana

Mivoatra hatrany ny fanabeazana ara-tontolo iainana mba hamahàna ireo olana tsy mitsaha-mitombo mikasika ny olana ara-tontolo iainana sy mba hahatongavana amin’ny vahaolana maharitra. Rehefa mbola miankina mivantana amin’ny firaisan'ny tontolo iainana sy ny asa aterany ny fahatsaram-piainan’ny mponina amin’ny toerana iray dia tena tsy azo ialàna io foto-kevitra voalaza etsy aloha io. Ny fitrandrahana tsy ara-drariny sy ny fomba fanao fampiasàna ny tany tsy ampiheverana dia miteraka tandindo amin'ny zava-boahary sarobidy tsy manampaharoan'i Madagasikara sy ny velontenan'ny tantsaha ao aminy. Na dia efa laharam-pahamehana eran’izao tontolo izao aza ny asa fiarovana ny tontolo iainana ao amin‘io firenena io dia hita fa mbola marefo ny fampiharana izany. Ambaran’ny paikady maneran-tany fa mitondra vahaolana goavana amin’izany ny fanabeazana ara-tontolo iainana ary tena ilaina tokoa mba hampivoatra ny fahalalàn’ny mponina izay hiara-mientana (afaka miara-mientana) ho amin’ny fampandrosoana maharitra.

Ity voka-pikarohana ity dia notontosaina tao amin’ny tetikasa AMBio na amin'ny teny baiko oe ‘Alaotra Marshland Biodiversity, adika tsotsotra hoe : Zava-boaharin’ny zetran‘Alaotra – izay ahitàna paikady maromaro ho fiarovana ny zava-boahary eto Madagasikara niainga avy amin’ny zava-misy ao amin’ny Farihiben'Alaotra. Mila mampiasa fomba fikarohana marolafy mifangaro ny asa fikarohana atao mba ahafantarana tsara ny lanjan’ny fanabeazana ara-tontolo iainana, ho fandraisana anjara amin’ny fiarovana ny tontolo iainana eo amin’ny Farihin’Alaotra sy ny manodidina. Isan’ny firenena mahantra indrindra eran-tany i Madagasikara ka mbola marefo arak’izany ihany koa ny rafi-panabeazana misy eo aminy. Ireo fikambanana tsy miankina amin’ny fanjakàna sasany dia mampihatra fandaharam-panabeazana ara-tontolo iainana hanamafisana ireo toe-tsaina tia miaro izany ary hampiatoana ny fanimbàna azy. Nasaina nampidirina tao amin’ny fandaharam-pampianarana ara-dalàna koa io fanabeazana ara-tontolo iainana io matetika mba ahafahana mampitombo ny vokatsoa azo avy aminy.

Tsy azo atao ambanin-javatra ny fahatakàrana ny fitondran-tenan’ny olona sy ny fomba fiheverany ny tontolo iainana mba ahomby ny asa fiarovana tontolo iainana atao sy ny fanatanterahana ny fanabeazana. Amin’ny fizaràna voalohany

ity voka-pikarohana ity dia mandalina mikasika ny fahalalàna, ny fitondran-tena ary ny fomba fiheveran'ireo mpampiasa ny loharanon-karena voajanahary eo amin’ny Farihiben’Alaotra manoloana ny lanjan’ny tontolo iainana. Ny fanadihadiana natao dia milaza fa tokony hampiharina amin-kalalahana ny fiarovana ny tontolo iainana rehefa tsy manohitohina ny velontenan'ny mponina. Ny fizaràna faharoa dia manao tombana mikasika ny fikasàna hampiditra ny fanabeazana ara-tontolo iainana eny amin’ny sekoly fanabeazana fototra, miaraka amin’ny rafi-pampianarana sy ny fomba fiheveran'ireo mpampianatra. Araky ny voka-pikarohana dia hita fa misedra fahasarotana ny rafi-panabeazana eo amin’ny fanomezana fanabeazana tsara kalitao mba anatanterahana ny fanabezana ara-tontolo iainana araka ny vinan’ny UNESCO izay misedra fahasarotany.Ny fizaràna fahatelo dia mandalina ireo traikefa mahomby, niainan’ireo mpiaro ny tontolo iainana amperin‘asa, mba ahitàna fomba fiasa azo antoka hanampiana ny mponina izay mahatsapa ny olana misy eo amin’ny tontolo iainana sy afaka miara-miasa mavitrika amin’ny famahàna izany eto Madagasikara. Ny voka-pikarohana tamin’io fizaràna io dia maneho ny lanjan’ny fiovàna ateraky ny fitsangatsangana eny amin'ny tontolo sy ny fiseraseràna amin’ireo mpanabe nivoaka avy tamin’ny ambaratonga ambony sady loharanon’ny aingam-panahy.

Ireo porofo nangonina sy natambatra avy amin’ity fikarohana mampihatra sy marolafy ity dia milaza fa afaka manampy amin’ny fandanjalanjàna ny asa fiarovana ny tontolo iainana sy ny fampandrosoana ny fanabeazana ara-tontolo iainana. Saingy mitaky sarany goavana ny fiampitàna amin’izany mba hahatonga ny fanabeazana ara-tontolo iainana amin’ny sokajim-pampianarana ambony kokoa izay manome vahana ny toe-tsaina mivelatra sy ny fanamafisana ny fahaiza-manao. Nefa raha tsy mianatra izany fiovàna izany dia ho very maina ny anjara asan’ny fanabeazana ara-tontolo iainana eo amin’ny fiarovana ny tontolo iainana sy ny fampandrosoana. Na izany aza dia nisy fanapahan-kevitry ny fitondram-panjakana vaovao manome fanantenàna satria mamela ny fanabeazana ara-tontolo iainana ho antoka enti-manatsara ny seha-panabeazana ka afaka mampifanjoy ny fiarovana ny tontolo iainana amin’ny fampandrosoana maharitra noho izany. Ity voka-pikarohana ity dia maneho ny zava-misy eny ifotony sy ireo sehatra tsara tsinjovina amin’ny fanamafisana fahaiza-manao, mba ahazoana antoka fa tsy an-tsoratra fotsiny ilay fanapahan-kevitry ny fitondràna ary mba hisy fanatanterahana tokoa. Ka hitombo araka izany ny taham-pahombiazana eo amin’ny sehatry ny fiarovana ny tontolo iainana sy ny fampandrosoana maharitra.

It takes a whole village to raise a child.

-African Proverb-

Chapter 1

General introduction

1.1 Background

In the past decades, systemic linkages between the environment, poverty, development, and education have become increasingly accepted. Responding to global change and uncertainties is one of the biggest challenges in the 21st century, especially for less developed countries (Lemos et al. 2013). Developing countries are often characterized by a combination of high biodiversity and poor rural populations, a majority of whom directly depend on the natural resources in their environments (Fisher & Christopher 2007). Many of these countries struggle to reconcile continuously increasing resource demands with the aims of biodiversity conservation, maintaining ecological functions, and sustaining local livelihoods (Sunderlin et al. 2005, Harvey et al. 2008, Brussaard et al. 2010). This setting makes conservation a particularly challenging task, and requires interdisciplinary approaches to consider these socio-ecological systems as complex dynamic systems, rather than considering their single components as individual phenomena (Fisher & Christopher 2007). According to global policy documents, education is key to solving these issues and reaching sustainable lifestyles (e.g., UNESCO 1975, 2013).

Madagascar is one of these countries struggling to reconcile conservation and development. The fourth largest island in the world has been classified as a biodiversity hotspot due to its high rates of endemism and threats to its flora and fauna (Myers et al. 2000, Ganzhorn et al. 2001); it is primarily renowned for its endemic lemurs, but also hosts exceptional numbers of endemic amphibians and reptiles (Glaw & Vences 2007, Vieites et al. 2009, Schwitzer 2017). However, as for many developing countries, biodiversity is threatened by progressive environmental degradation, overexploitation of natural resources and unsustainable land-use practices (Harper et al. 2007). One of the country's main challenges is to reconcile conservation with population needs, including poverty alleviation (Rakotomanana et al. 2013). The majority of Madagascar's population depends on subsistence agriculture and the country is one of the poorest globally; 88% of the 23.6 million people live below the poverty line of $1.25 (UNDP 2015).

Moreover, education in Madagascar is weak; public primary schools largely suffer from overcrowded classes and a lack of trained teachers (Glick & Sahn 2006, UNDP 2015). As a consequence, 58% of youth do not graduate from primary school, and only 3% succeed in completing secondary education (EPDC 2016). Despite extensive international donor attention, the aims to end poverty, improve education and livelihoods, and protect wildlife and ecosystems have not yet been reached (Horning 2008, Waeber et al. 2016).

Global policy frameworks and corresponding research suggest that environmental education can offer an effective means to address these issues. Environmental education is recognized as a tool to educate a responsible citizenry that will actively contribute to sustainable development, including actions to protect and improve the environment (UNESCO 1975, 1976). However, despite Madagascar's urgent need to find solutions that can reconcile conservation and development, EE is not a compulsory element in the Malagasy school curriculum (Dolins et al. 2010). This thesis explores the opportunities and constraints of a potential inclusion of EE into the Malagasy school curriculum. The following sections provide in brief the theoretical background, main concepts and methodology used throughout this thesis.

1.2 Environmental education in brief

Environmental education (EE) has often been declared to be able to support a societal transformation towards a sustainable way of living. Such a lifestyle is envisioned to be realized by responsible and informed citizens, oftentimes called 'environmentally literate', who will actively participate in shaping the planet in a sustainable manner (WCED 1987).

The concept of EE emerged in the 1960s due to increasing concern about environmental issues threatening the quality of human life and ecosystem sustainability, including climate change, ecosystem destruction, biodiversity loss, resource depletion and population growth, but also waste disposal or nuclear and chemical threats (UNESCO 1975, Fien 1995, Gough 2013). The interdisciplinary field deals with relationships of humans, society, and the environment, thus embracing sociocultural, economic, and environmental dimensions.

One of the first definitions of EE was formulated by Stapp (1969):

> "*Environmental education* is aimed at producing a citizenry that is *knowledgeable* concerning the biophysical environment and its associated problems, aware of *how* to help solve these problems and *motivated* to work toward their solution" (Stapp 1969: 30-31, emphasis in the original).

The UNESCO formulated the goals of environmental education as follows:

(i) "to foster clear awareness of, and concern about, economic, social, political and ecological interdependence in urban and rural areas;
(ii) to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment;
(iii) to create new patterns of behavior of individuals, groups and society as a whole towards the environment." (UNESCO 1978: 24)

Implicit to the UNESCO policy guidelines and official documents are three educational approaches embraced by the theoretical framework of education *about*, *in*, and *for* the environment (Figure 1.1). These components were first identified by Lucas (1972), and were extensively discussed in the scientific literature after publication of the UNESCO policy documents (e.g. Tilbury 1992, Fien 1993, Palmer 1998, Ferreira 2009). While each approach has its own objectives and teaching style, the three dimensions together allow a holistic development of the UNESCO objectives in learners, i.e., awareness, knowledge, attitudes, and skills to actively participate in solving environmental problems (UNESCO 1975, Fien 1993, Palmer 1998). EE as education *about* the environment addresses awareness, knowledge, and understanding about the environment, with an emphasis on cognition. This is the prevailing approach used for EE in schools, e.g., in science or geography curricula (Tilbury 1992, Fien 1995). Education *in* or *through* the environment aims to develop awareness and concern regarding the environmental situation. It is a more pupil-centered and activity-based approach with experiential learning opportunities and more flexible teaching styles. The third component of the framework, education *for* the environment, focusses on actual preservation and improvement of the environment, i.e., active participation and respective skills of learners in the resolution of environmental issues (ibid). It represents a practical teaching and learning style, and incorporates 'critical education' goals. Teachers, instead of

being instructors, take the role of facilitators, while the addition of social and political aspects to the environmental perspective allows a holistic and interdisciplinary study of environmental issues, enabling learners to take responsibility and to reflect on their own actions and their influences on the environment. However, the focus on action, participatory approaches and controversial issues make this approach the most complex and – given the purpose, structure and dominant practices of schooling – the most neglected in curricula and classrooms (Tilbury 1992, Stevenson 2007).

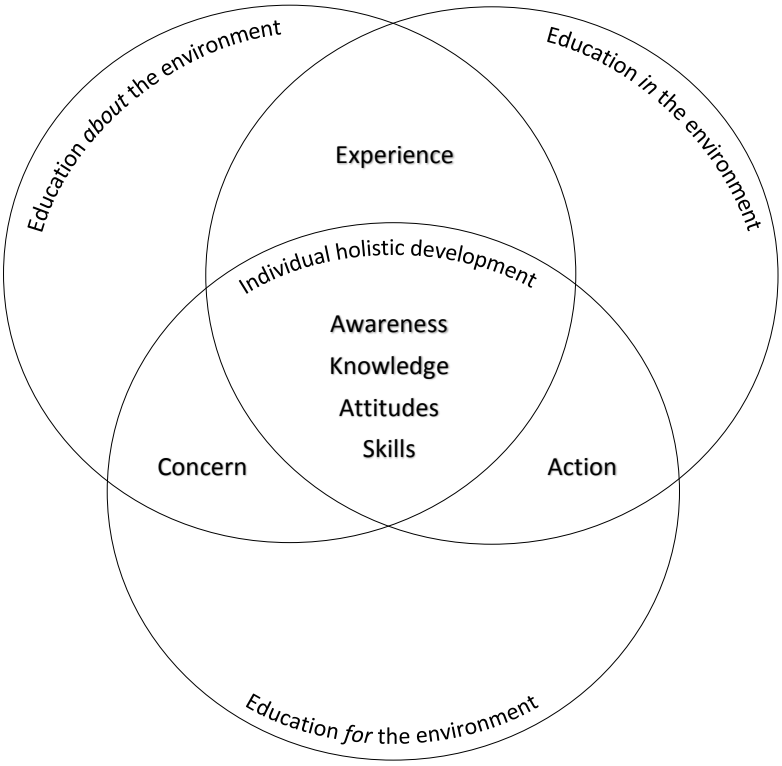

Figure 1.1 A model for holistic EE teaching and learning (modified from Palmer 1998: 145).

The three components are linked and critical to individuals' development into becoming environmentally responsible citizens. The approach of education *for* the environment is especially crucial for this, but its transformative potential can only unfold on a relevant basis of education *about* and *in* the environment (Fien 1993). It has been assumed that people who have an understanding of the environment would take actions to prevent or address environmental problems in their

surroundings, i.e., contribute towards a sustainable development (Palmer 1998). Tilbury (1995) described education *about* the environment as a 'head approach', education *in* or *through* the environment to address the 'heart' component through contact with nature, and education *for* the environment as involving the 'hand'. Together, she argued, the three components would provide a holistic theoretical framework for learning about environmental problems, herein covering the EE objectives of the global UNESCO documents.

In the late 1980s, the dominant discourse turned towards education for sustainability (EfS) and education for sustainable development (ESD), but disagreement continues to fuel discussions whether ESD is an extension and amelioration of EE, or a specified strand of it (e.g. Fien 1995, Tilbury 1995, McKeown & Hopkins 2003, Pavlova 2011). Some see ESD as successor of EE, while others argued that ESD does not add anything new to the initial ideas of EE (Sauvé 1996), and others question the conceptual and ethical (economic) foundations of ESD (Jickling 1992, Stevenson 2006, Jickling & Wals 2008). Yet other scholars discuss the legitimatization of behaviorist and constructivist positions (e.g. Jickling 1992, McKeown & Hopkins 2003, Sterling 2010, Kopnina 2014), while yet another distinction between the concepts is informed by environmental ethics, where EE is rather seen as an eco-centric concept, whereas ESD represents an anthropogenic worldview. It is beyond the scope of this study to discuss the existing interpretations; in the end, these concepts are abstractions that depend on context as well as being in constant need of reexamination (Jickling 1992), and may mean different things to different schools of thought (Bonnett 2002).

Following the UNESCO definition (Pigozzi 2003), ESD involves:

> "Integrating key sustainable development issues into teaching and learning. This may include, for example, instruction about climate change, disaster risk reduction, biodiversity, poverty reduction and sustainable consumption. It also requires participatory teaching and learning methods that motivate and empower learners to change their behaviours and take action for sustainable development. ESD consequently promotes competencies like critical thinking, imagining future scenarios and making decisions in a collaborative way."

Considering this, EE as well as ESD share the goal of a sustainable society. Both aim at enhancing individuals' capacity to bring about change in that direction or towards that goal (Ferreira 2009). Given the concerns raised regarding ESD (e.g. Stevenson 2006, Jickling & Wals 2008), and considering the broad context in which the present thesis is conducted, the term environmental education (EE) is used as an umbrella term to embrace concepts such as conservation education, education for sustainability and education for sustainable development.

1.3 EE *for* conservation in Madagascar

Nature conservation is a difficult task in Madagascar, as mentioned above. Historically, conservation was preservation-oriented until the 1970s; local people were excluded, meaning that their forest-based subsistence activities were restricted or even denied without due compensation (Mehta & Kellert 1998). The emerging park-people conflicts led to the understanding that local stakeholders need to be involved and their livelihood concerns taken into account in planning and implementing conservation policies and programs (Sunderland et al. 2007, Reibelt & Nowack 2015).

Environmental education interventions have since been implemented in several regions to promote pro-conservation attitudes and values in (future) resource users. Most programs focus on children in primary schools, as these institutions offer the opportunity to reach the highest proportion of Malagasy learners. However, EE has not been implemented into the national primary school curriculum despite long-term efforts and repeated promises and initiatives by governmental agencies (Dolins et al 2010). One reason amongst others may be the political instability of the country (cf. Randrianja 2012b).

To fill that gap, EE interventions are mostly carried out by western nongovernmental organizations (NGOs) or individuals (e.g. Korhonen & Lappalainen 2004, Patel et al. 2005, Maminirina et al. 2006, Ormsby 2008, Freeman 2009, Dolins et al. 2010, Keane et al. 2011, Rakotomamonjy et al. 2015, Richter et al. 2015). Their goal is to provide at least some basic insights into issues related to the environment and ecosystem services to achieve behavior change towards a more sustainable future (Richter et al. 2015). A review of three conservation education projects in Madagascar showed that teachers mainly applied banking education (Dolins et al. 2010). The teachers did not use teaching styles that promoted critical thinking, displayed low knowledge levels regarding

the environment and conservation, and low motivation in general. To increase the possibilities of EE being implemented in schools, it has been repeatedly proposed to include EE in formal teaching all over the country so as to impart environmental knowledge and values to the future resource users (e.g. Ratsimbazafy 2003, Dolins et al. 2010).

To be able to judge possible future directions of EE in Madagascar, it is necessary to know local people's knowledge and perceptions of the environment so as to draft adequate educational interventions. Furthermore, knowing people's perceptions and values is important for conservation success (Agrawal & Gibson 1999), but also for the teaching and learning of EE (Kimaryo 2011; Hashemzadeh 2016). Knowing perceptions in society (henceforth the *resource users*) can then inform EE practice in schools. This in turn requires an assessment of school structure and *teacher* capacities to assess the conditions for EE. Moreover, drawing on formative experiences of dedicated *conservationists* represents a suitable approach to inform future educational practice about promising approaches (Chawla 1999). This thesis addresses the three stakeholder groups (resource users, teachers, conservationists) to allow multi-dimensional insights about the knowledge and perceptions that may influence the development of future resource users' views, and the opportunities of EE to contribute to conservation.

1.4 Research questions and objectives

The main goal of this thesis is to explore whether environmental education can contribute to conservation at Lake Alaotra in Madagascar. In order to inform policy and education practices, this applied research explores three main research questions (RQs):

RQ1) Are the natural resource users supportive of conservation?
RQ2) Can teachers realize environmental education in public primary schools?
RQ3) What kind of experiences lead to active individuals contributing to conservation?

The specific objectives are:

O1) to explore awareness, knowledge, and perceptions of local resource users concerning conservation values (*Chapter 3,4*)
O2) to assess the school structure and teacher capacities in terms of readiness for environmental education (*Chapter 5*)
O3) to identify potential drivers of and barriers to the implementation of environmental education in public primary schools (*Chapter 6*)
O4) to identify the experiences and persons that Malagasy conservationists and environmental educators judge important in developing an interest in the natural environment (*Chapter 7*)

1.5 Methodology

This thesis was conducted in the realms of the AMBio project: 'Alaotra Marshland Biodiversity – strategies for the conservation of biodiversity in Madagascar using the example of Lake Alaotra'. The interdisciplinary project was a cooperation between the University of Hildesheim, Germany and the NGO `Madagascar Wildlife Conservation´, Madagascar. Three PhD students conducted research to gain a better understanding of the socio-ecological system of Lake Alaotra; the three-pronged approach included an ecological, economic, and educational perspective. The ecological study aimed to assess the state of the marshlands including water quality parameters, invertebrate community, vegetation and fish composition. A sociocultural and economic feasibility study was conducted about alternative usages of the invasive water hyacinth (*Eichhornia crassipes*), including usage of the plant as compost and handicraft raw material. The educational perspective was covered by the present thesis, considering the opportunities and constraints of EE in schools and society of the Lake Alaotra region.

This applied research takes an inter- and transdisciplinary approach in the context of environmental education. The choice to conduct a case study implies that the research is explorative and descriptive, while applying a mixed-method approach including qualitative and quantitative data. Research in the region around Lake Alaotra served to answer research questions one and two; for research question three, a national sample of conservationists and environmental educators assisted for data collection.

1.5.1 Case study region

To answer the research questions, this thesis applied a case study methodology. The Lake Alaotra region in Madagascar was especially suitable to serve as a case study due to its economic and ecological importance and its well-documented environmental education efforts (see details in *Chapter 2*).

The region is a main supplier of rice and freshwater fish (Andrianandrasana et al. 2005) while its remaining marshes host the Critically Endangered *Hapalemur alaotrensis,* endemic to the region (Mutschler et al. 2001, Ralainasolo et al. 2006, IUCN 2014). Overexploitation and mismanagement are causing an increasing deterioration of the natural environment and declining outputs in crop production and fisheries, which in turn leads to further marsh degradation and destruction (Ratsimbazafy et al. 2013, Waeber & Wilmé 2013).

To counteract this downward spiral, mainly two NGOs have been engaged in educational interventions in the region for over ten years. Durrell Wildlife Conservation Trust (Durrell) runs awareness raising campaigns in parallel to local biodiversity conservation interventions (Andrianandrasana et al. 2005) and Madagascar Wildlife Conservation (MWC) ran an EE comic book project between 2006 and 2012 in 12 public primary schools around the lake (Maminirina et al. 2006, Rendigs et al. 2015, Richter et al. 2015). Evaluations showed that MWC's EE project increased pupils' knowledge levels concerning the environment when compared to control groups; additional interactive learning material further increased levels of knowledge and retention (Rendigs et al. 2015, Richter et al. 2015). Richter et al. (2015) concluded that the additional material stimulated peer-to-peer learning, and highlighted the positive impact of locally meaningful EE material.

Chapter 2 provides a more detailed account on the Lake Alaotra region and recent conservation, education and research projects in the area.

1.5.2 Methods

Data resulting from the following sampling methods formed the empirical basis of this thesis: structured interviews, focus groups, and questionnaires. Archival research and observation was used to complement and verify information. The multi-method approach allowed for triangulation, thereby increasing the quality and trustworthiness of the collected data. Different measures were taken to ensure reliability and validity of data and their analysis, e.g., pre-testing of interview and survey guides, iterative discussion and interpretation processes within research teams and with study participants, and intercoder reliability. Each of the chapters provides detailed information on the respective methods and data analysis. All research realized in the realms of this thesis was conducted following the ethical code of conduct later laid down by Wilmé et al. (2016).

1.6 Thesis outline

This thesis deals with the deconstruction and reconstruction of EE in Madagascar. Deconstruction is used in the sense of breaking something down, i.e., analyzing something by considering its separate parts. The separate parts considered in this thesis represent the different societal influences on the future resource users: the children. These include resource users in the community, teachers at school, and conservationists from NGOs. The obtained understanding is then used in the overall discussion to explore opportunities and constraints of EE, and to propose measures to reconstruct (environmental) education.

The thesis consists of eight chapters, framed by the general introduction and the synopsis (Figure 1.2). *Chapter 2* provides additional information to the case study site, including past and present conservation efforts.

The core of the thesis are the *Chapters 3 to 7* which are ordered according to the following themes: (i) assessing community perceptions – *Chapters 3 and 4*; (ii) status quo of the school system and identification of drivers and barriers to EE – *Chapters 5 and 6*; (iii) identification of formative life experiences of Malagasy conservationists and environmental educators – *Chapter 7*.

Chapters 2–5 and *Chapter 7* are published in peer-reviewed journals, and *Chapter 6* is ‘in revision’; the title pages of the chapters provide the respective citations.

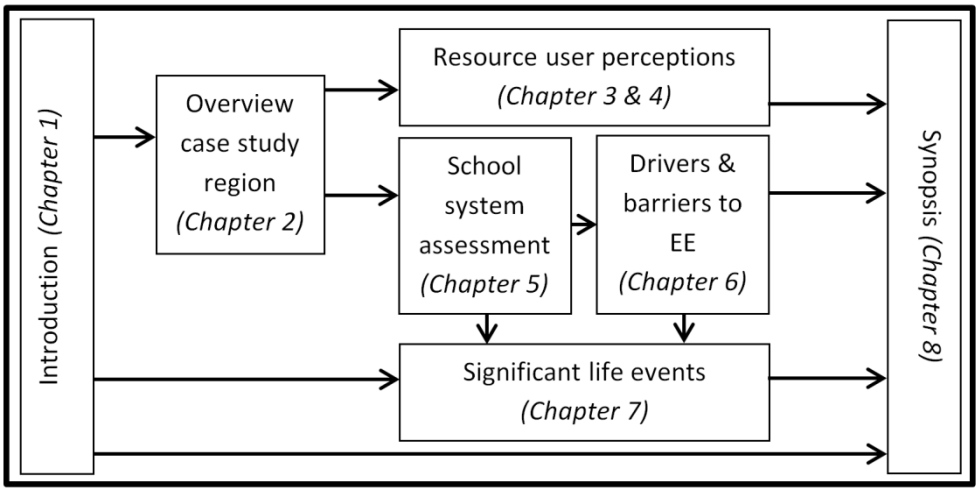

Figure 1.2 Schematic outline of the thesis

Chapter 2 provides a socio-economic characterization of the case study region, including an overview of increasing conflicts between conservation and agriculture, as well as past and present educational interventions and research projects. *Chapter 3 and 4* explore the perceptions of local resource users around Lake Alaotra towards the flagship lemur species *Hapalemur alaotrensis* and the special conservation zone 'Park Bandro'. Both chapters are based on survey data from 6 sites around Lake Alaotra.

In *Chapter 5 and 6*, the focus is on primary public schools (EPPs). In *Chapter 5*, teachers' perceptions of the environment and environmental problems are investigated through in-depth interviews in 12 public primary schools. Moreover, the school structure and teaching methods are inquired. *Chapter 6* builds on findings of *Chapter 5* and assesses teachers' personal awareness and attitudes, and professional competency to identify potential drivers and barriers for the implementation of environmental education in EPPs. *Chapter 7* presents the retrospective evaluation of Malagasy conservationists and environmental educators as to which experiences and persons had a formative impact on them and their interest in the natural environment.

Finally, in *Chapter 8*, a synopsis on the main findings of this thesis and its implications for conservation in Madagascar is provided. The contribution of the results to current research is discussed together with future research prospects and opportunities, and conclusions are drawn.

Chapter 2

Introduction to the case study region and conservation efforts

Abstract. Natural resource management problems typically involve a multitude of stakeholders with diverse sets of needs and interests, and often conflicting worldviews in an environment with growing uncertainty. Such problems are termed "wicked" problems, where there are no right or wrong solutions, only more or less acceptable ones. In the case of Lake Alaotra, growing agricultural pressures have a negative impact on the wetland biodiversity and especially on the Alaotra gentle lemur (*Hapalemur alaotrensis*) restricted to these marshlands. The species survival is highly uncertain because of increased habitat loss caused mainly by marshland fires. The conservation work for this unique lemur is complex and complicated and requires the involvement and collaboration of decision-making institutions, NGOs, universities and riverine communities. From the inception of projects to their implementation phase, all parties need clearly defined responsibilities and transparency in communication in order to run projects successfully. This article describes the approach that Madagascar Wildlife Conservation has been implementing during the past ten years at Lake Alaotra, discussing the plan of action and challenges for environmental education, ecotourism and alternative livelihoods.

Published as: A Rendigs, **LM Reibelt**, FB Ralainasolo, JH Ratsimbazafy & PO Waeber 2015. Ten years into the marshes – *Hapalemur alaotrensis* conservation, one step forward and two steps back? *Madagascar Conservation & Development*, 10(1): 13–20. http://dx.doi.org/10.4314/mcd.v10i1.S3.

2.1 Introduction

Madagascar is renowned for its high endemic biological diversity, rich forests and a wealth of natural resources (Ganzhorn et al. 2001, Randriamalala & Liu 2010, Raharimahefa 2012). However, the country is also plagued by environmental degradation, low agricultural productivity and poverty; over 80% of the population lives below the poverty line of $US 1.25 a day. The country ranks 151 out of 186 in the UNDP Human Development Index (UNDP 2013). Since 2009, political instability has further undermined economic development, amid a global financial crisis that has accentuated impacts on the poor, leading to increased food insecurity (Randrianja 2012b). The political instability and the connected break-down in law and order has also directly weakened conservation efforts such as the prevention of rosewood trade (Schuurman & Lowry II 2009, Innes 2010, Randriamalala & Liu 2010), or fuel led the crisis in the tortoise trade in the southwest of Madagascar (Hudson 2013). Furthermore, the country is at risk of increased vulnerability and degradation from anticipated climate change (Hannah et al. 2008).

The 'rice bowl' of Madagascar. Agriculture alone provides around 27% of GDP (gross domestic product), 40% of exports and ensures a living to about 75% of the Malagasy population (INSTAT 2011). The primary economic driver in the two Lake Alaotra districts Ambatondrazaka and Amparafaravola is based on fishery and rice production, providing one third of the country's rice output (Andrianandrasana et al. 2005). The area is characterized by terraced, rice-growing valleys lying between grassy, deforested hills. There are three types of rice production: irrigated (surrounding the marsh belt of Lake Alaotra), rain-fed (on the hill slopes of the Alaotra basin), and *contre-saison* (within the marshlands of Lake Alaotra). The two lake districts are the biggest rice producing areas in the Alaotra-Mangoro, totaling 345,265 tons (irrigated production), 20,000 tons (rain fed) and 17,400 tons (*contre-saison*), respectively (Monographie Régionale 2012). The (agro-) economic importance of the Alaotra-Mangoro (such as rice, fish, artisanal and industrial mining) has encouraged human migration into the region. The population has thus increased from some 110,000 people in the 1960s to nearly 550,000 in 2010 for the regions of Amparafaravola and Ambatondrazaka (INSTAT 2012). The growing demand for arable land coupled with a continuously dwindling productivity per unit of agriculture (Bakoariniaina et al. 2006) is leading to increased destruction of marshlands, putting additional pressures on marshland

biodiversity. The forests around Lake Alaotra have been replaced, probably post-LGM (last glacial maximum; Waeber et al. 2015a) by open landscapes showing the typical lavaka (erosion gully) features widespread in the region (Kusky et al. 2010). Some 250,000 zebus pasture the hill slopes (Ministère de l'Élevage 2013) contributing further to the exposed landscapes (for example, burning for fodder production, or mechanical trampling of soil). Downhill sedimentation and siltation are affecting Lake Alaotra by reducing its size, which ranges between 35–40 km length and 5–9 km width, depending on the season (Bakoariniaina et al. 2006). These erosion effects are accentuating the pressures also felt on the surrounding rice fields, for example reducing their productivity (Raharijaona-Raharison & Randrianarison 1999).

Alien pressure. The water hyacinth (*Eichhornia crassipes*) originating from South America, is known as one of the most invasive plant species worldwide (Villamagna & Murphy 2010). Reducing fish stock and diversity (Gratwicke & Marshall 2001), causing waterway clogging, but also worsening of water quality are some of the effects of *E. crassipes* invasion (see Mangas-Ramírez & Elías-Gutiérrez 2004, Villamagna & Murphy 2010), which can cause also economic and social burden for the local population (Gunnarsson & Petersen 2007). Many fishing grounds are not accessible anymore and fishermen either have to invest in clearing waterways or burn further marshland vegetation for better access to fishing grounds. In the Alaotra wetland system, mostly endemic fish species are impacted by *E. crassipes* whereas exotic fish such as *Tilapia spp.* and more so *Channa maculata* can still persist in water with lower oxygen levels (Pidgeon 1996, Courtenay & Williams 2004).

Marshlands and its biodiversity disappearing 'in a puff of smoke'. Madagascar's forests have always been the focus of the international conservation community due to its rich biodiversity. That is, the high degree of endemism and level of threat found in these unique forests. Only since the beginning of the 2000s have wetlands begun receiving some conservation attention. Since 2003, Lake Alaotra and its wetlands were designated a Ramsar site (Ramsar site no. 1312), and in 2007 the area also received NAP status (Nouvelle Aire Protégée; new protected area; N°381-2007/MINENVEF/MAEP, 17 January 2007). Lake Alaotra is the largest freshwater lake in Madagascar and with an average depth of 1–2.5 m a shallow water body (Ferry et al. 2009). The fringing marshland vegetation is dominated by reed (*Phragmites communis*) and cyperus (*Cyperus madagascariensis* and *C.*

latifolius). Some unusual, endemic mammals have a narrow range limited to the lake, such as the Durrell mongoose (*Salanoia durrelli*), discovered in 2004 (Durbin et al. 2010) and the Alaotra gentle lemur (*Hapalemur alaotrensis*). This is the only swamp-dwelling primate (Mutschler et al. 2001, Waeber et al. in Press b). Genetically a congener of the forest-dwelling *Hapalemur griseus, H. alaotrensis* is ecologically adapted to marshland conditions (Mutschler & Feistner 1995, Mutschler et al. 2001, Mutschler 2002, Waeber et al. in Press a). However, the future of this primate, classified by the IUCN as Critically Endangered (Andriaholinirina et al. 2014), is highly uncertain given the continuously growing pressures on the marshland ecosystem, mainly in the form of marshland fires (Guillera-Arroita et al. 2010a, 2010b, Ratsimbazafy et al. 2013); the last population estimations from 2005 reported numbers below 3,000 individuals (Ralainasolo et al. 2006). This article presents ten years of conservation efforts at Lake Alaotra, analyzing the conservation approach taken by Madagascar Wildlife Conservation (MWC), which is based on a multilayered community involvement. The findings are critically discussed, including which approaches worked and especially which did not, serving to share MWC's experiences in wildlife and conservation management.

2.2 Strategies and objectives

The Alaotra wetlands, important agriculturally and host to unique fauna represent a complex and complicated system (sensu Pietronero 2008). The challenge is seeking a balance between conservation and development or as Murphree (2002: 2) stated "if conservation and development could be simultaneously achieved, the interest of both could be served (…)". By ensuring the maintenance of marshland ecosystem services and function, both the livelihood of the riverine communities as well as the survival of *Hapalemur alaotrensis* could be served. A positive example of achieving this is the temporary fishing closure around Lake Alaotra (15 November–15 January). The result was an increase in fish size and with that, corresponded improved prices at the local markets, at least during the period 2002–2008 (J. Randriamahefasoa, pers. observ.). Acting in a complex system requires the analysis of various scales and value-dimensions simultaneously in order to avoid the 'one correct perspective' (Berkes 2004). There are many different actors, each with their own value system, needs and agendas. To address this 'wicked problem' (sensu Rittel & Webber 1973), MWC pursues a

multilayered, multipurpose and transdisciplinary approach (cf. Sayer et al. 2008, Selman 2009), with the following strategies and objectives:

Prioritizing conservation zones: The Park Bandro (local name of the Alaotra gentle lemur) is situated in the marshes of the village Andreba Gare and is classified as priority conservation zone (*Zone Prioritaire de Conservation*; ZPC), which is the highest conservation category within the NAP. Within an area of 85 hectares, it shelters the highest density of *H. alaotrensis* found in the Alaotra region (Ratsimbazafy et al. 2013). The high population size can be attributed to the protected zone, which allows for continuous reproduction but prevents migration due to its isolation. The objectives of this conservation strategy are to (i) maintain a core sub-population that can act as a source, or population pool, for linking with other sub-populations; (ii) showcase the natural habitat for the people of Andreba and other villages; this park can act as an 'open class-room' for various resource user groups; and (iii) attract tourists who are interested in a unique primate that thrives in marsh habitat. The ultimate and overall goal of this park is to increase the chances of the survival of the lemur in its natural environment.

Valuing the 'bandro': By promoting the flagship species *H. alaotrensis*, tourists can visit the region and hence create local value for an intact marshland ecosystem (see Durbin 1999, Feistner 1999, Thalmann 2006, Durbin et al. 2007). The Camp Bandro just outside the village Andreba Gare and close to the lake provides five bungalows, one cafeteria, and sanitation facilities. The ecotourism infrastructure in place allows community members to source additional income (for example, by working as guides, cooks and providing accommodation). This model results in benefits for individual members and has indirect benefits to the entire community.

Increasing environmental awareness: This strategy focuses its efforts on the main future resource users: primary school children who are encouraged to learn, take interest, appreciate and understand their environment. Education is a prerequisite for a better standard of living as well as a founding contributor towards wildlife conservation (UNDP 2013). The school children around Lake Alaotra are motivated to engage actively in the sustainable use of their natural and agricultural resources through educational comic books and posters used in the school lessons, interactive material for group work and excursions onto the lake. Environmental education increases awareness towards environmental issues, raises public sensitivity and appreciation for the importance of an intact

lake and preserved marshes and offers ideas for positive action (Ehrlich & Pringle 2008, MENRS 2008). Teachers naturally play a key role in education delivery and receive regular environmental education trainings.

Encouraging new perspectives: A majority of community members sustain their livelihood through different sources. In order to ease the pressure of marshland natural resources, one objective is to identify potential resources (What kind of resources are un-used so far?) and test new resources that are available and accessible to a majority of the community (What is technically and economically feasible? What is socially and culturally acceptable?). The invasive *Eichhornia crassipes* represents a promising option for alternative or supplement sources of income.

2.3 Implementation

Linking marshland conservation and tourism: how to engage communities? In 2004, 85 hectares of intact and dense marshland vegetation were put under protection by DREF (Regional Directory of Water and Forest) with the support of the Durrell Wildlife Conservation Trust in the Andreba *fokontany* (village). Park Bandro hosts the biggest *Hapalemur alaotrensis* sub-population with an estimated 170 individuals (Ratsimbazafy et al. 2013). The VOI (vondron' olona ifotony, community-based natural resource management association), founded in 2001, is responsible for the management of the park, which comprises maintenance of the canals (such as freeing them from *Eichhornia crassipes*, other congestive vegetation and mud) as well as regular patrolling to enforce park boundaries. The park can be accessed by pirogues and likely offers the prime viewing location for *H. alaotrensis*. In 2005, MWC started its ecotourism project. Ecotourism has the potential to increase the acceptance of a protected area, as it offers an alternative source of income to the people of the adjacent villages (Ormsby & Kaplin 2005). The guides who collaborate with MWC have been trained, and collaborative initiative with the local VOI has been established to ensure benefits for villagers. For each boat visiting the park, the VOI receives a portion of income that contributes to park management. In a subsequent phase, Camp Bandro is host to tourists that visit the park in early morning hours. The camp is presented in *Sihanaka* style (ethnic group from the Alaotra) and run by locals from the Andreba Gare community. Starting with 17 visitors in 2007 the number of tourists has gradually increased to over 50 per year. Additionally, the camp is used as a base

for researchers working adjacent to Lake Alaotra as well as for workshops for local organizations. MWC also uses its income to support community-based microprojects. The local MWC Andreba section, together with representatives from the Andreba Gare community, prioritizes which community projects to support using the camp's revenue. Market stalls in Andreba's market place, pirogues (small boats) for the park visit, a soccer tournament, or the World Lemur Festival Andreba have so far been financially supported. During these community celebrations, MWC highlights the link between the intact marshes, Park Bandro, the Camp Bandro and the tourists that come to visit the area to view lemurs.

Targeting future resource users. In 2006, MWC started the comic project Arovy fa harena (protecting natural wealth), producing comic books aimed at primary school-aged children in the Alaotra region to increase knowledge, understanding and awareness of the regional characteristics of the ecosystem and ecological relationships. In eight short episodes, the main characters (children and animals) introduce their respective worlds and values to each other in a manner that is accessible to children and culturally adapted to the region. The conservation messages include marsh burning, fishing, *H. alaotrensis* biology, the importance of reed and *Cyperus*, and reforestation (cf. Maminirina et al. 2006). The comic books have been distributed in twelve elementary schools around the lake (Figure 2.1) and teachers have been trained during annual workshops in ecology, biodiversity, and environmental issues. To date, 100 teachers, school directors and members of the school authorities have been trained and 3,000 of the comic books have been distributed in schools around the lake. To assess the impact of the comic books on school children's knowledge and understanding of ecosystem-related topics, an evaluation was conducted with structured questionnaires in a control group design with three survey periods; before, immediately following, and one year after introducing the comic books into the school program. Out of the 540 test pupils, one group per school was equipped with additional material encouraging interactive learning, while another group served as a control. That is, they did not have contact to the environmental education material. Initial analyses confirmed a trend of increased knowledge after the introduction of the comic books into the school lessons (Dolins et al. 2010); this effect has been increased when teachers used the supplementary interactive teaching material. Even after one year, the increased levels of knowledge were sustained, confirming teachers' anecdotal evidence that the comic books are still of utility.

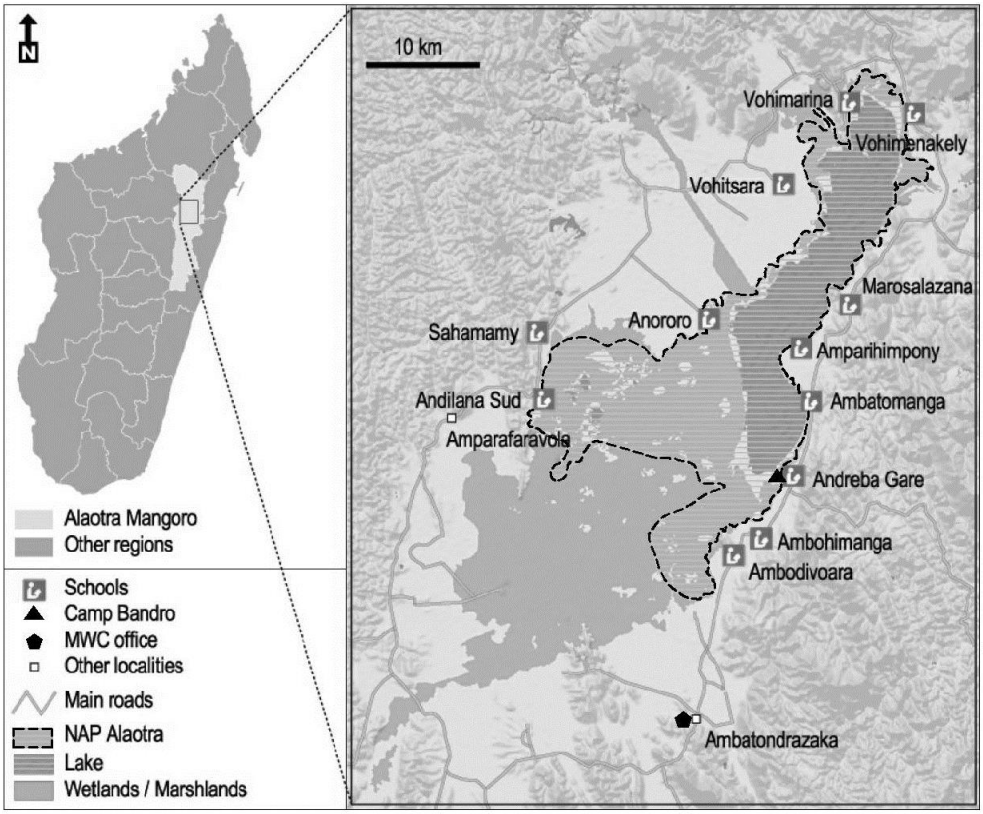

Figure 2.1 Location of public primary schools around Lake Alaotra engaged in the comic book project.

Some of the comic book classes have been selected to visit Park Bandro during a school excursion to view *H. alaotrensis* in its natural environment; the majority of children in the Alaotra region have never seen a lemur. This is generally the case across Madagascar (Ratsimbazafy 2003). In order to complement the educational material, MWC developed an educational poster in collaboration with the McCrea Foundation, Durrell, UNICEF and the Ako Project in 2011 on which Alaotra's biodiversity is presented. The benefits of a healthy environment – such as ecosystem services – for animals and humans are explained in Malagasy and English illustrating the characteristic fauna of the region. These posters have been distributed in all schools that are working with MWC. The latest MWC training in collaboration with ENS Antananarivo (École Normale Supérieure) and the participation of 35 teachers at the end of 2013 addressed, besides ecological and educational topics, how to implement the comic books and the educational

posters into different school lessons such as Malagasy, French, geography and mathematics. Current research carried out within the AMBio project, a collaboration between MWC and University of Hildesheim, Germany, focuses on a long-term and sustainable approach to providing environmental education in Alaotra's primary schools. Interviews and group meetings help assess the status quo of environmental education and identify drivers and barriers for further development (cf. Reibelt et al. 2014).

Investigating in alternative resources use. The Alaotra marshlands provide a range of important ecosystem services to the communities of adjacent villages. *Zozoro* or cyperus (*Cyperus madagascariensis*) and *vohoaka* (*C. latifolius*) are used for construction purposes and handicrafts; *revaka* or chick weed (*Ageratum conyzoides*) and *tsy hita fototra* or dodder (*Cuscuta sinensis*) are used as medicinal plants (for example, as a remedy for stomach complaints). *Betsimihilana* or water lily (*Nymphaea sp.*) is used in traditional ceremonies (for example, during the *joro*, a metaphysique ceremony to thank or consult with the *zanahary* (God) or the ancestors; S. H. N. H. Rakotoarimanana, In lit.). The marshes host the breeding ground for fish, the main source of protein for the local population (Wallace 2013). They also act as natural filter and water reservoir (Andrianandrasana et al. 2005) and play an important role in maintaining the hydrological balance in the Alaotra basin, crucial for rice production (Copsey et al. 2009b). Worldwide, several studies have dealt with the various options of using *E. crassipes*. The usage of this invasive plant represents a reasonable alternative to the costly and complex efforts to control it (Brendonck et al. 2003). Moreover, it offers an economic benefit. Despite its abundance, *E. crassipes* is only used marginally in the Alaotra. MWC has performed a first feasibility study in 2008 to investigate the potential of this invasive plant as a briquette and alternative to charcoal (Meier 2008). The lack of electricity, infrastructure and technical support make *E. crassipes* an unrealistic option for charcoal. Using *E. crassipes* as a raw material for woven handicraft products (for example, baskets, place mats) did, however, show promise (ibid). The AMBio research (2012–2015) focuses on approaches that are likely to be successful in the Alaotra. For example, *E. crassipes* is suitable as fodder (Jianbo et al. 2008), can be used for production of compost (Gajalakshmi et al. 2001a, 2001b, Malik 2007), and for braiding handicraft products (Lindsey & Hirt 2000, Jafari 2010). The ongoing research in AMBio thus focuses on improving and testing of handicraft products (for example, comparing different thicknesses and weaving techniques of *E. crassipes*). Aerobic and anaerobic compost experiments

are being performed to assess the economic and technical feasibility and comparing the *E. crassipes* compost with commercially available fertilizers.

2.4 Challenges and remediation measures

In this section, it is discussed what approaches did not succeed during the ten years of conservation work with the communities, reasons are scrutinized and possible remediation measures are presented. Key to the following review are participation, communication, mutual respect and motivation.

Understanding marshland fires. Since the early 1990s, Durrell has been engaging mainly in the marshes of Andreba Gare to research the behavior and ecology of *Hapalemur alaotrensis* (Mutschler et al. 1998, Nievergelt et al. 1998, Mutschler et al. 2000, Nievergelt et al. 2002a, Nievergelt et al. 2002b, Waeber & Hemelrijk 2003). Since 2003, MWC and Durrell have been working collaboratively. The presence of researchers (mostly foreigners) and the engagement of locals in the various conservation and research projects have resulted in some effects: no fires for approximately 20 years have been registered in the marshlands of Andreba. However, fire events north and south of Andreba have steadily increased and represent a serious threat for the Park Bandro which is now isolated from other marshland patches (Ratsimbazafy et al. 2013). Local explanations to marshland burning include the collection of the invasive fish species *Channa maculata*, the development of new rice fields, lemur hunting and accidental fires (Copsey et al. 2009a). In particular, the establishment of new rice fields poses a serious threat to the ecosystem as no regeneration of the marshland vegetation is possible following this disturbance. Currently, it is unclear whether local or external actors are responsible for initiating these fires. In addition, the presence of conservation bodies such as Durrell or MWC (who are accompanying the DREF, *Direction Régionale des Eaux et Forêts*, during the fire data collection) is not well received in some communities around Lake Alaotra. There is evident mistrust towards, or fear of potential repression from government representatives. Social disruption is also occurring. An example is given by the commune of Vohimarina in the north of the lake. Since April 2013, (coinciding with presidential elections campaign in Madagascar, cf. Waeber & Wilmé 2013) the community is split into a pro-conservation group and, opposingly, a group propagating the free access and redistribution of protected marshland for rice cultivation. In order to understand processes and interactions in the wetland system, the AlaReLa project

(collaboration between MWC, École Supérieure des Sciences Agronomiques–ESSA Forêts, ETH Zurich, amongst other partners) addresses the marshland fire system and other changes in the wetlands following participatory action research (sensu Whyte 1991). Companion modeling (ComMod) is a community-based scientific approach to facilitate collective action (Bousquet et al. 1999, Barreteau et al. 2003). The first step of the ComMod approach consists in collectively identifying a problem and an associated research question. Then the ARDI (Actors, Resources, Dynamics, Interactions) methodology is often deployed to analyze a problem and the involved components and processes (Etienne et al. 2011). The initial ARDI workshops around the lake have been promising and participants appreciate the opportunity to communicate freely without fearing consequences (Garcia et al. 2015).

Park bandro management. As part of a national target established by former President Ravalomanana to protect 10% of the country's terrestrial surface (Norris 2006), 93 NAPs were identified in 2003 for key areas of biodiversity. The aim was to establish legal frameworks with state-approved management plans for the NAPs prior to May 2015. The creation of NAPs followed a national program of management transfers of natural resources from state control to local communities (GCF, Gestion Contractualisée des Forêts, forest management contracts, and GELOSE, Gestion Locale Sécurisée, secure local management), which has led to many communities taking over the management of habitat areas most often with extensive external NGO and financial support. In many cases, communities have lacked several of the core skills required to take on the management of these areas, which are official legal contracts between the communities and the government (Ratsimbazafy et al. 2013, Pollini et al. 2014). To date, Alaotra went through the steps of undertaking environmental and social impact assessments (in 2010). However, a management plan, the most important strategic document towards official ratification, is still outstanding. These events coincided with the 2009 political crisis. The Park Bandro, a priority conservation zone, represents a source of ongoing conflict between the different actors from the Andreba Gare community. This is largely due to the lack of transparency and inequity in responsibility and decision-making surrounding management of the park. Anecdotal evidence suggests that the VOI, as the officially recognized steward of the Park Bandro, is having insider knowledge (i.e., being the sole actor involved in park delineation, without informing other stakeholders), and of having an exclusive understanding of how NAP operates. Some of the income generated

from park entrance fees that were supposed to be reinvested into park maintenance have been diverted without clear explanation or have simply evaporated. The tourist Park Bandro guides have been switching between different associations, that is between MWC and Zetra Maitso (a local association). This has led to more confusion than clarity. "Equity and empowerment are often more important than monetary incentives for community-based conservation" (Berkes 2004). To avoid competition between different associations in the future, it is envisioned to reorganize the guides under one single umbrella body, the DREF. These guides will be recognized as official and legitimate guides that will be subject to regular training following Madagascar National Park's ethical and structural guidelines. This will ensure that all guides are respectful towards park visitors, towards themselves and to the lemurs.

Social acceptance and long-term impact. *Hapalemur alaotrensis* is used as a flagship species for MWC's ecotourism project. A community meeting was held with the *tangalamena* (village elders) prior to the onset of the project, to seek consent and approval of the project, but mostly to see whether there was actual interest in such a project. In MWC's environmental education program, targeting public primary schools, the CISCO and teachers have been consulted on potential interest in the comic book project. In both projects, there were strong indications in favor of beginning the respective projects. A 'community', as stated by Carlsson (2000), consists of dynamic (evolving), cross scale, multi-dimensional and social-political networks. The *fokonolona* (this is known as the community where all residents register at the administrative subdivision within the village, aged eighteen years and older and residing in the district and territorial base of the village) is not a fixed or consistent entity for residents (cf. Pollini & Lassoie 2011). There is confusion and disagreement among members of the Andreba Gare community regarding decision-making and benefit-sharing in the ecotourism project. The camp has been established and funded by MWC. Some of the locals have found permanent salary positions, while others benefit by guiding occasional tourists. A majority, however, sees no benefit in having an ecotourism facility such as the Camp Bandro in the community, or they are indifferent to the initiative. Becoming part of the 'social landscape' is a process that will take time (cf. Richard & Ratsirarson 2013), meanwhile MWC is engaging different community groups to participate in a variety of activities in and around the Camp Bandro. According to UNESCO's definition, 'environmental education' aims to increase awareness of the environment and the challenges it faces. Knowledge, positive attitudes,

motivation and skills are crucial to facilitating environmental education (UNESCO 1975). In MWC's environmental education program, material such as comic books, teacher training and monitoring are sourced from outside of the system. This bares the risk that the project will cease when funding ends or any other external factor influences or disrupts education delivery. For the sustainable implementation of environmental education into the school program of the region, that is, to have a long-term impact on the future resource users, it is unavoidable to do a status quo assessment. Within the realms of the AMBio project, research focuses on the institutional settings, and the director and teacher level to identify opportunities for and constraints to environmental education.

2.5 Conclusion

One step forward and two steps back? The challenge in the conservation of *Hapalemur alaotrensis* lies in the complexity of the marshland social and local political systems. The conservation of the lemur species represents a typical 'wicked problem' with no singularly true or wrong solutions, only solutions that are better or worse, or more or less acceptable. An adaptive approach, or sometimes even a 'muddling through' (cf. Sayer et al. 2008) seems the likely and realistic approach for learning and bringing conservation efforts forward. This requires a holistic view of the system that targets problem areas in order to manage its inherent connectedness. To ensure success, conservation efforts are required to be scaled up to the entire marshland area and not center on few isolated communes. A concerted effort is hence required shouldered by a broad partnership of many different and diverse institutions and actors; the most important of which is the community. In this context, it is key that (i) management power and responsibilities are shared continuously and consistently, and (ii) a collaborative environment between the different actors is created that promotes learning and stewardship to ease mutual respect and trust. Madagascar Wildlife Conservation's (MWC) attention in its early years concentrated exclusively around the promotion of awareness and appreciation of the Critically Endangered *H. alaotrensis*. In retrospect, MWC missed an opportunity to emphasize the need to fully comprehend the perspective of the community. In order to ground the conservation efforts, MWC is progressively acquiring a broad understanding of the various existing stakeholders, and mapping and understanding their respective needs, values and power relations.

Understanding the latter can help avoid misunderstandings and reduce the likelihood of friction between the various actors. Research projects like the AMBio or AlaReLa allow both sides, MWC and the communities, to listen and learn from and understand each other better. In complex management problems, different knowledge systems come with different value perspectives; Berkes (2009) suggests using both knowledge systems, academic and local as complementary, in 'dialogue and partnership'. In order to develop conservation strategies that find the support of the entire community for the long-run, continuous and transparent communication is key. The community should be involved at all project stages, from inception of a project (such as the conceptualization phase) through to the final stages. Using this approach, it is likelier that the community views their ownership within the process and sees tangible benefits in a project. However, it is of utmost importance to engage various segments of a community (acknowledging that the actor 'community' itself is a complex structure) within a project to circumvent perceptions of inequity in decision-involvement. By using the 'ingredients' of mutual respect, shared and clearly defined responsibilities, transparent communication, in addition to ensuring the various incentives of shared decision making and benefits, all parties involved can be supportive of continued efforts to conserve *H. alaotrensis*.

Chapter 3

Communities' perceptions of the special conservation zone 'Park Bandro'

Abstract. Management and monitoring of community-based protected areas in Madagascar remain challenging because of a lack of financial, human and technical resources, and capacity. At Lake Alaotra, conversion of marshland for rice cultivation and a lack of effective habitat protection have pushed the locally endemic Alaotran gentle lemur *Hapalemur alaotrensis* to the brink of extinction. The highest density of the species is found in the locally managed Park Bandro, a high-priority conservation zone within the Lake Alaotra New Protected Area. We evaluated local awareness and perceptions of Park Bandro, and discussed preferred management options with local communities. Two questionnaire surveys were carried out, one with 180 participants at six sites around the lake and marsh, and another with 50 participants in the village adjacent to Park Bandro. The majority of participants knew of the existence of Park Bandro but most did not know its purpose or size. Values and perceptions of local communities were influenced by occupation and distance to Park Bandro, with fishers being most aware of the Park. We found that local people had a high level of environmental awareness and were willing to discuss zonation and alternative resource management strategies as long as these activities could provide a tangible livelihood benefit. Lack of awareness among local resource users regarding the purpose and status of protected areas such as Park Bandro is a challenge that needs to be addressed, and one that is relevant for environmental education and management of protected areas throughout Madagascar.

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3.1 Introduction

A central pillar of the conservation of threatened species and biodiversity is the establishment of protected areas, with 15.4% of terrestrial surfaces having some form of protected status (Deguignet et al. 2014). Of the six IUCN categories of protected areas (cf. Dudley et al. 2010) only Category V (protected landscape/seascape) focuses on human-nature interactions (Gardner 2011). During the 6th World Parks Congress in 2014 it was recognized that protected areas are not to be appreciated solely for intrinsic values but are to be seen as a reservoir for future generations to safeguard ecosystem services for the surrounding local communities (McNeely 2015). This is in line with the paradigm change that has occurred in the past five decades, in which conservation has moved away from 'nature for itself' towards a 'people and nature' approach (Mace 2014).

Madagascar was one of the first countries to establish a protected area network, creating its first National Park in 1927. At the 5th World Parks Congress in 2003, Madagascar declared it would triple the terrestrial surface under national protection, to 6 million ha, under the Durban Vision (Norris 2006). The new System of Protected Areas of Madagascar, which includes the management of the original protected areas as well as New Protected Areas, is responsible for safeguarding biodiversity and cultural heritage and sustainably managing resources for the people of Madagascar (Commission SAPM 2006). Although the integration of mutual benefits for human well-being and biodiversity has increasingly become the focus in Madagascar (Reibelt & Nowack 2015), the management and monitoring of protected areas is proving to be difficult because of a lack of technical capacity and financial and human resources (Rakotoarivelo et al. 2011, Rasolofoson et al. 2015, Waeber et al. 2016).

The Critically Endangered Alaotran gentle lemur *Hapalemur alaotrensis* (Andriaholinirina et al. 2014) is the only lemur species that lives exclusively in marsh habitat (Waeber et al. 2016), and the entire global population of the species is found in the marshes surrounding Lake Alaotra, within the boundaries of the Lake Alaotra New Protected Area. The species faces a high extinction risk as a result of a significant decline in population size and an ongoing reduction in the area, extent and quality of marsh habitat. The population declined from 7,500–11,000 individuals in 1994 (Mutschler & Feistner 1995) to <2,500 by 2005 (Ralainasolo et al. 2006), and has continued to decline. Historically, *H. alaotrensis*

has been poached for keeping as pets and for food (Mutschler et al. 2001, Andrianandrasana et al. 2005). Although hunting pressure has declined in recent years, destruction of the lemur's marsh habitat continues unabated (Ratsimbazafy et al. 2013) and presents a threat to the survival of the species.

Park Bandro is situated in the marshes managed by the village of Andreba and is designated a priority conservation zone, representing the highest conservation category within the New Protected Area. The 85 ha park shelters the highest density *of H. alaotrensis* (Ratsimbazafy et al. 2013) and is the best place for seeing the species in the wild (Rendigs et al. 2015). Experiences elsewhere have shown the importance of local people's acceptance and attitudes towards zones set aside for conservation (Ormsby & Kaplin 2005, Bennett & Dearden 2014, Osunsina & Fagbeyiro 2015). The objectives of our study were to evaluate local awareness and perceptions of Park Bandro, and assess preferred management options within the local communities surrounding the Lake Alaotra New Protected Areas, to provide guidance for future environmental education and management plans.

3.2 Study area

The Alaotra region is characterized by an agriculturally dominated landscape that is also home to small-range endemic taxa, including *H. alaotrensis*. Lake Alaotra covers 20,000 ha and is the largest lake in Madagascar; it is surrounded by 25,000 ha of marshland and 130,000 ha of rice fields (Figure 3.1). The area is of high socio-economic importance as Madagascar's largest area for production of rice and fish (Copsey et al. 2009a, 2009b). The Alaotra wetlands were designated a wetland of international importance under the Ramsar Convention in 2003, and in 2007 the area was given temporary New Protected Area status in national law. Permanent protected area status was approved in June 2015 and the area was designated a community-managed protected area, IUCN Category V.

The human population around Lake Alaotra is dependent on fishing and rice cultivation (Ranarijaona 2007, Wallace et al. 2015). Marsh burning, siltation and conversion to rice fields have reduced the marshes of Lake Alaotra to <25% of their historical extent of 60,000–80,000 ha (Bakoariniaina et al. 2006). Conversion of marshland for rice cultivation has escalated, likely coordinated by people of power from outside the region, for their own financial benefit and aided by a low level of law enforcement (Ratsimbazafy et al. 2013, Waeber & Wilmé 2013). This pressure and the lack of legal protection for the marsh prior to the permanent

status granted for the Lake Alaotra New Protected Area in June 2015 have brought *H. alaotrensis* to the brink of extinction.

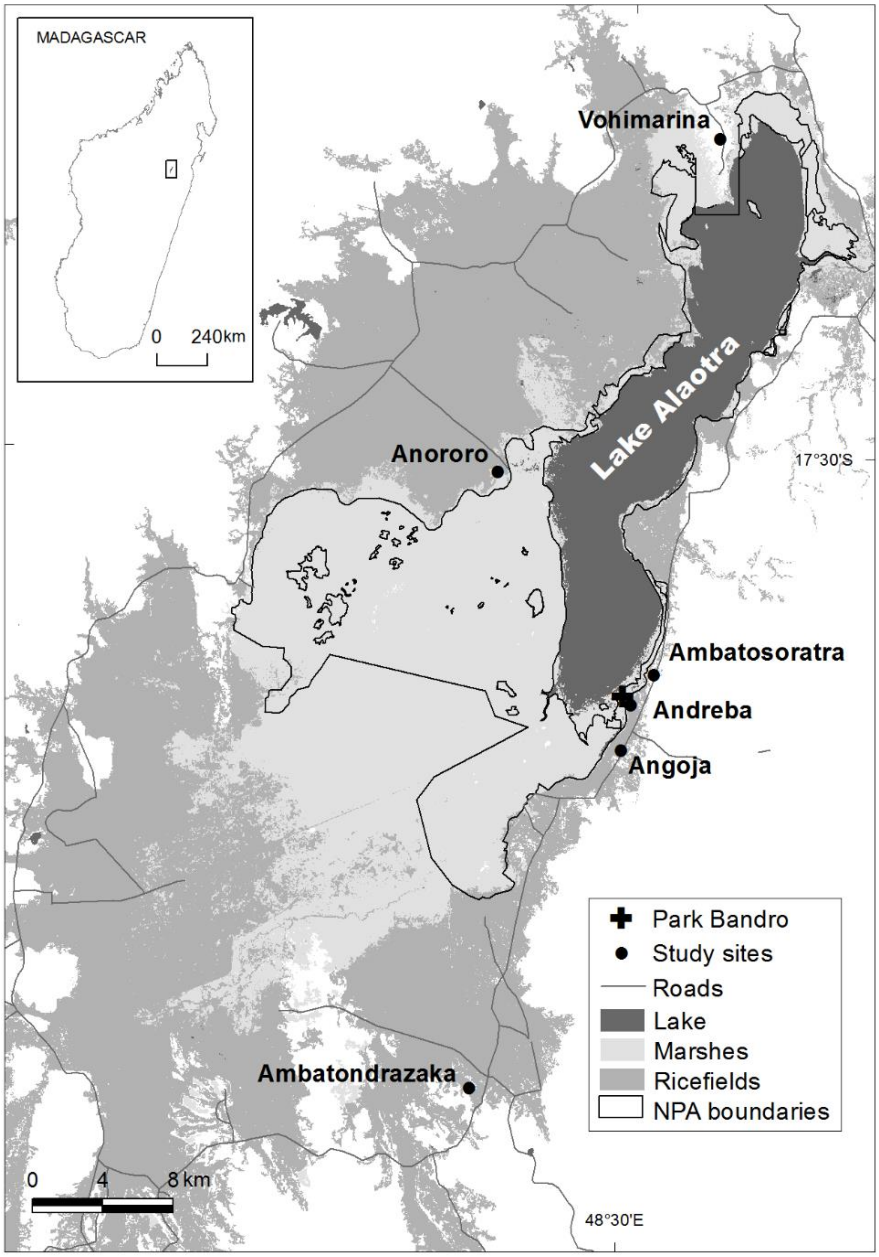


Figure 3.1 The locations of the six study sites in the vicinity of the Lake Alaotra New Protected Area (NPA) in Madagascar.

3.3 Methods

Two surveys were conducted in 2015 to quantify the levels of knowledge and awareness of Park Bandro amongst communities around Lake Alaotra. Survey 1 was carried out in July 2015, with 180 participants in six villages around the lake: Ambatondrazaka, Anororo, Vohimarina, Ambatosoratra, Andreba and Angoja (Figure 3.1), selected to represent varying distance from Park Bandro. Survey 2, in September 2015, targeted 50 participants, all from Andreba, which is the village closest to Park Bandro. Both surveys collected information on the age, gender, level of education, geographical location and main livelihood activity of each interviewee (Table 3.1). We applied purposive sampling (Bernard 2006) at each site, interviewing participants at the lake or close to the marshes, and at the closest market where the products from lake and marshes are sold. We assumed that people interviewed along the marshland borders and at the market were natural resource users and were in some way, directly or indirectly, affecting or dependent on the marsh and lake system. For Survey 1 we questioned 10 participants in the morning, 10 at noon and 10 in the evening (i.e. 30 interviewees per site). Surveys were anonymous and administered in Malagasy by two research assistants, who were briefed and trained beforehand. One of the research assistants led the survey and the other took notes to compensate for varying levels of literacy among interviewees. Notes were translated into French and the resulting raw data delivered to and discussed with the researchers. Survey questions had been formulated in French, translated into Malagasy, and then translated back to French to refine the wording and meaning; pilot studies had been conducted for both surveys, and formulations were adjusted where needed to eliminate ambiguity. Except for ranking questions (Figure 3.3, p. 53) and questions about management options (Supplementary Material 3.1, p. 61) and differences inside and outside Park Bandro, the questionnaire contained open questions. For responses to the open questions we conducted quantitative content analysis with inductive creation and establishment of categories (cf. Lamnek 2005). The categories were discussed and adapted in an iterative process within the research team. Categories were then translated into English before statistical analysis. Summary statistics of all answers were calculated. To test for differences we used Fisher's exact test, the $\chi 2$ test, the t-test and the two-sample Wilcoxon rank-sum test in R versions 3.0.3 and 3.2.1 (R Development Core Team 2015). We followed the principles described in the ethical code of conduct of Wilmé et al. (2016).

Table 3.1 Details of participants in questionnaire surveys carried out around Lake Alaotra, Madagascar (Figure 3.1) in 2015, including study village, region, distance to Park Bandro (PB), sample size, age range of participants, and main livelihood activities.

Village	Region	Distance to PB (km)	Sample size (male/ female)	Age range (years)	Main livelihood activities
Survey 1					
Ambatondrazaka	South	24.0	30 (16/14)	14–60	Student, farmer, houseworker
Anororo	West	14.7	30 (24/6)	16–67	Fisher, weaver, farmer
Vohima-rina	North	32.4	30 (17/13)	15–75	Farmer, fisher, weaver
Ambatosoratra	East	2.1	30 (26/4)	18–60	Fisher, farmer, duck walker
Andreba	East	0.7	30 (30/0)	15–75	Fisher, farmer, student
Angoja	East	3.1	30 (25/5)	15–75	Fisher, fish collector
Survey 2					
Andreba	East	0.7	50 (33/17)	15–73	Farmer, fisher, student

Survey 1 focused on quantifying people's knowledge about Park Bandro. Questions focused on whether participants knew of the existence of the Park, and its size and purpose, whether they visited it and why, whether they perceived individual benefits or constraints resulting from the Park's existence, and what kind of management option they would prefer. Survey 2 focused on the village of Andreba and explored the values of various land and resource uses. The survey addressed people's perceptions of the conservation importance of Park Bandro, the role and benefits of locally active NGOs, the impact of the establishment of the park, and management options for the marshes and fishery.

3.4 Results

In Survey 1, 58% of the 180 participants indicated fishing as their main livelihood activity, followed by farming (17%), student (6%), and weaving (3%); the remaining 16% replied 'other' (e.g. fish collector, duck walker, teacher). A higher proportion of respondents in Survey 2 were farmers (40% of the 50 participants), followed by fishers (28%), students (10%), weavers (4%) and other (18%).

To examine differences in levels of environmental awareness between sites and user groups we compared years of schooling between smaller, remote villages around the lake (Anororo, Vohimarina, Ambatosoratra, Andreba and Angoja) and the regional capital (Ambatondrazaka), and between user groups. Participants from Ambatondrazaka had significantly more years of schooling (mean 10.1) than participants from any of the lake-adjacent sites (all sites, *t*-test, $P<0.0001$; overall mean=6.9). Fishers exhibited the highest levels of environmental awareness despite having significantly fewer years of schooling than all other user groups (*t*-test, $P=0.0001$).

3.4.1 Park Bandro

Over half of the 180 participants (56%) in Survey 1 were aware of the existence of Park Bandro. People living in villages closer to the Park showed higher levels of awareness than those living further away (Figure 3.2; Fisher's exact test, $P<0.0001$). Significantly more fishers knew about the Park than non-fishers (Fisher's exact test, $P<0.0001$). When asked about the Park's legal status 13% of participants said it was a protected area, another 12% correctly stated that it was managed by the local community association, 11% believed it was a National Park, and 64% did not know its legal status (Table 3.2). When asked to estimate the size of the Park, 67% did not know, 22% estimated <25 ha, and 11% estimated 25–28 ha. Thirty percent stated that the Park had been created for conservation, and 61% did not know the purpose of the Park. The remainder thought it had been created for fish reproduction (4%), tourism (2%), job creation and community benefit (2%), and for the environment (1%). The most frequently cited advantages of Park Bandro were conservation (39%), tourism (21%) and job opportunities (16%). No one cited any disadvantages.

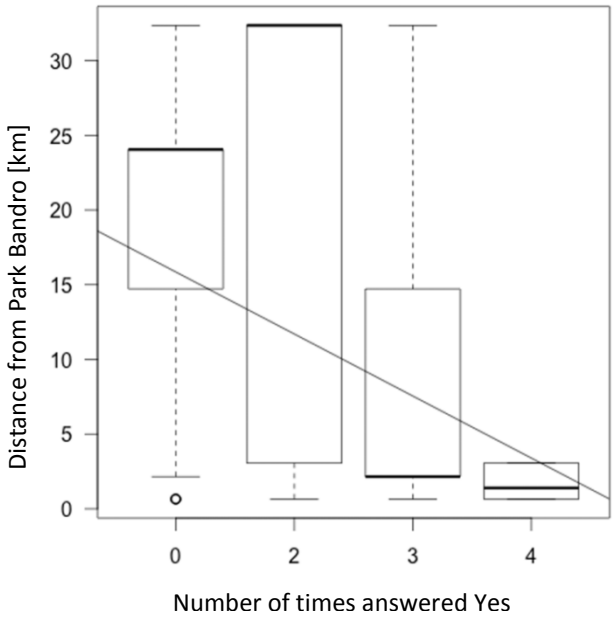


Figure 3.2 A boxplot showing correlation between distance to Park Bandro (cf. Figure 3.1) and the composite variables (i.e. all questions that could be answered yes or no), with the linear regression line.

A subsample of 30 people from Andreba were asked in Survey 1 about differences in the status of plants and animals within and outside Park Bandro. The most common replies were that more animals (27% of replies) and denser vegetation (20%) are found inside the Park. Conversely, respondents stated that there were fewer animals (13% of replies) and less vegetation (17%) outside the Park, and that exploitation of animals (27%) and plants (20%) occurred outside the Park (Table 3.2).

All 50 participants in Survey 2 stated that Park Bandro did not inconvenience them, the most common reasons being that there is enough area outside the Park for them to work (32%) and that areas where people work do not overlap with the Park (34%). When asked about changes since the Park's creation in 2004, people replied that numbers of *H. alaotrensis* (mentioned in 52% of replies), tourists (50%) and fish (50%) had increased.

Table 3.2 Responses to a questionnaire survey carried out around Lake Alaotra, Madagascar (Figure 3.1) in 2015, to elicit the perceptions of local communities about the Park Bandro special conservation zone.

Questionnaire responses	Sample size	No. of respondents (%)
Park's legal status		
Protected area	180	23 (12.8)
Managed by community association	180	21 (11.7)
National Park	180	18 (10)
National Park managed by community association	180	2 (1.1)
Don't know	180	116 (64.4)
Park size (ha)		
1–85	180	59 (32.8)
0–5	180	16 (8.9)
6–25	180	23 (12.8)
26–36	180	5 (2.8)
37–85	180	15 (8.3)
Don't know	180	121 (67.2)
Park location		
Near Andreba	180	101 (56.1)
Don't know	180	79 (43.9)
Park objective		
Conservation	180	54 (30)
Fish production	180	8 (4.4)
Attract tourism	180	3 (1.7)
Environment	180	2 (1.1)
Community benefits	180	1 (0.6)
Job creation	180	1 (0.6)
Conservation & tourism	180	1 (0.6)
Creation by the government	180	1 (0.6)
Don't know	180	109 (60.6)
Park advantages		
Conservation	180	70 (38.9)
Tourism	180	38 (21.1)
Other job opportunities	180	29 (16.1)
Pleasure	180	7 (3.9)
Increased precipitation	180	7 (3.9)

Questionnaire responses	Sample size	No. of respondents (%)
Prestige	180	6 (3.3)
Differences between inside and outside the Park		
More animals inside the Park	30	8 (26.7)
Denser vegetation inside the Park	30	6 (20)
Park is used for conservation	30	8 (26.7)
Fewer animals outside the Park	30	4 (13.3)
Animals are exploited outside the Park	30	8 (26.7)
Plants are exploited outside the Park	30	6 (20)
Fewer plants outside the Park	30	5 (16.7)
Perceptions of Park Bandro		
It is not inconvenient	50	50 (100)
There is enough area outside the Park to work	50	16 (32)
The Park does not overlap with work areas	50	17 (34)
What has changed since the Park's creation in 2004?		
Increase in the number of *H. alaotrensis*	50	26 (52)
Increase in the number of tourists	50	25 (50)
Increase in the number of fish	50	25 (50)
Decrease in marshland degradation	50	10 (20)
Increase in local income	50	9 (18)

3.4.2 Values and perceptions of the marshes

In Survey 2, focused on the village of Andreba, the 50 participants were asked what the marshes meant to them. The most common answers were habitat for wildlife (23%), a place to make a livelihood (15%), a source of handicraft materials (15%), fish habitat (13%), water reservoir (11%), and plant diversity (9%). All participants considered the marsh to be important, the main reasons being that it supports livelihoods (15%), attracts rainfall (13%), and serves as fish habitat (12%). When comparing the marshes with other land types, such as lake, agricultural zone, forest, and open landscape, respondents considered the marshes to be the most important habitat, ranking open landscape as the least important land type (Figure 3.3). The main reason given for the highest ranking was that the marsh was a place of work supporting local livelihoods (Table 3.3).

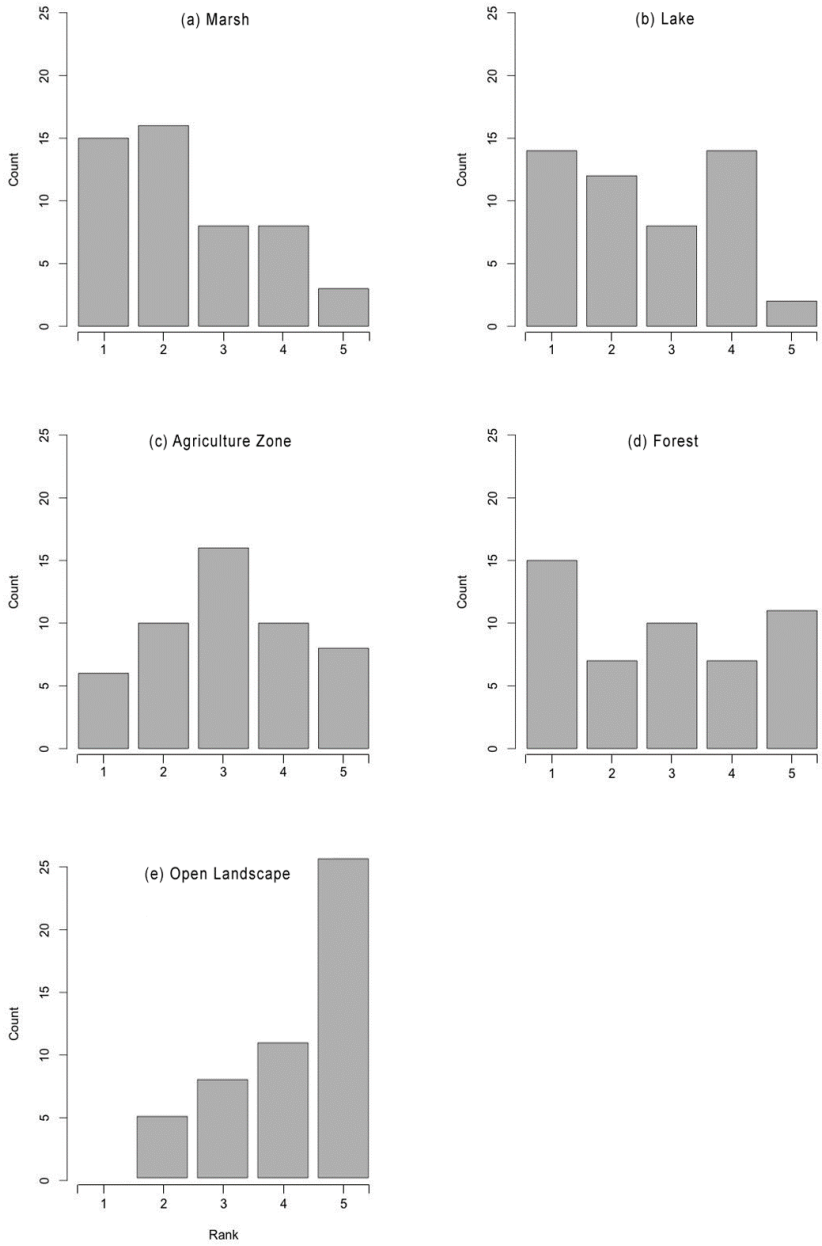


Figure 3.3 Ranking of land zones by the 50 participants from Andreba (Figure 3.1) according to importance (1=very important, 5=not important at all).

Table 3.3 The most common reasons given by Survey 2 participants for highest or lowest ranking of land zones (cf. Figure 3.3).

	Reasons: ranked least important	Reasons: ranked most important
Forest	Forest is too far away	Forest attracts rain, protects soils, and protects natural environments; lake depends on forest
Lake	Lake is too risky (high uncertainty regarding size of fish catch)	Place of work; place for life; place for fishing; marshes depend on the lake
Open landscape	Infertile soils; don't work there; too dry; no benefit; seasonal work only; too far away	None reported
Agriculture zone	Don't work there; not enough space; difficult watering; no work; less important than fishing; this zone depends on the four ecosystems (forest, lake, open landscape/ grasslands, marshes)	Place of work; agriculture is prestige; I'm a farmer; my only property
Marshes	Occasional work only; don't work there; don't know how to fish	Place of work; place for life; siltation protection; fish habitat; rice plantation; source of income

3.4.3 Conservation and management

To examine the local community's awareness and perception of NGOs, the 50 participants in Survey 2 were asked which NGOs were active in their local area (Table 3.4). The most common replies were the VOI (a general term for a community association; 82% of replies) and Zetra Maintso (a village association concerned with marsh management; 38%); specific conservation NGOs were also mentioned, including Durrell and Madagascar Wildlife Conservation (22%). Regarding NGO activities, the most common responses were marshland protection (22%), environmental awareness (11%) and rural development (9%).

Regarding fishery and marshland management, only 6% of participants (n=50) opted for no temporal or spatial fishing closure (Management strategy A, Supplementary Material 3.1, p. 61; Table 3.4). The main reasons given were that fishing is a gift from God, and that fishing should be allowed year round. Forty-six percent of people opted for no temporal closure but with fixed conservation zones, as this would 'allow fishing year round' and 'allow for fish development' (Management strategy B, Supplementary Material 3.1). Forty-eight percent of interviewees opted for a closed fishing season (Management strategy C, Supplementary Material 3.1), a policy that is currently in place. Most common responses in support of a closed season were the 'promotion of fish reproduction' and 'fish development'.

Table 3.4 Local community perceptions of the roles of conservation NGOs and preferred management options for protected areas at Lake Alaotra (Figure 3.1). There was no significant difference in the choice of management options between occupational groups (fishers, farmers and others).

	No. of times this answer was given	Percentage [%], n=50
Type of activities done by NGOs (Give 3 examples)		
Marshland protection	33	66
Environmental awareness	17	34
Rural development	14	28
Material donations	11	22
Monitoring fisheries	9	18
Raising awareness to reduce marsh fires	4	8
H. alaotrensis conservation	4	8
Clearing channels of invasive aquatic plants in Park Bandro	6	12
Training in weaving	4	8
Agricultural techniques	1	2
Handicrafts	1	2
Tourism jobs	2	4
Have you worked with an NGO?		
Yes	12	24
No	36	72
No, don't know any NGOs	2	4
Best way to manage fishery?		
Strategy A: without closed fishing seasons or permanent closed fishing zones	3	6
Strategy B: without closed fishing seasons but with the establishment of permanent reserves where fishing is prohibited throughout the year	23	46
Strategy C: closed fishing season during Nov.-Jan. (a policy that is currently in place)	24	48
Common reasons for choosing strategy A (Give 2 reasons)		
Fishing is a gift from God	1	2
Fishing should be allowed year-round	2	4
Common reasons for choosing strategy B (Give 2 reasons)		
Fishing year round	23	46
Allowing for fish development	11	22

	No. of times this answer was given	Percentage [%], n=50
Common reasons for choosing strategy C (Give 2 reasons)		
Promotion of fish reproduction	24	48
Fish development	22	44
Best way to manage marshlands?		
Strategy A: distinct zoning for *H. alaotrensis* and agriculture (participants from Andreba) [land sparing]	49	98
Strategy B: no zoning at all [land sharing]	1	2
Common reasons for choosing strategy A (Give 2 reasons)		
Better protection of *H. alaotrensis*	43	86
There's enough space for both agriculture and conservation	17	34
To stop hunting of *H. alaotrensis*	8	16

3.5 Discussion

In situ efforts for lemur conservation have thus far focused on ecological monitoring by the Comité Forestier Local network (Andrianandrasana et al. 2005), reporting and documenting marshland fires within the protected area (Ratsimbazafy et al. 2013), and establishing community engagement (Rendigs et al. 2015). Anthropogenic pressure is high and increasing (Ratsimbazafy et al. 2013). There was little law enforcement, especially during the crisis years, with land conversion for rice production instigated by actors from outside the Alaotra system (Waeber & Wilmé 2013, Garcia et al. 2015). The challenge for conserving the Alaotran gentle lemur is that increasing numbers of people are entering the marshes of Alaotra to pursue livelihood strategies and converting marsh to rice fields. However, participants stated that they respected the boundaries of Park Bandro and did not perceive any inconvenience from its existence. They also believed the Park was important for increasing fish stocks and local income. However, none of the participants knew the size or exact boundaries of the Park, and the legal status and goal of the Park were unclear to most people. A similar scenario was reported for Masoala National Park, where residents were aware of the Park's existence but not of its purpose (Ormsby & Kaplin 2005). In reality, the availability of lemur habitat in Park Bandro is declining as a result of encroachment by illegally established rice fields. Enforcement of environmental

laws has been hampered at Alaotra by the lack of visible boundary markers for protected areas, even for strict conservation zones such as Park Bandro, which have been decided upon by local communities themselves during open, transparent meetings. Our results reinforce this, with the majority of people interviewed unable to state the size and purpose of the Park. Without understanding the purpose and potential positive impacts of a protected area, or knowing the delimitation of a protected area's boundaries, how can local communities be expected to support the protected area and respect its borders? Nonetheless, this illegal land conversion has taken place in small patches and Park Bandro has not experienced a major fire for more than 20 years, in contrast to outside the Park, where large areas of the marshes (1–45% per annum during 2000–2009) have been burned during the dry season (Ratsimbazafy et al. 2013).

Understanding the perceptions and values of local communities is an essential step towards conservation management, as local support for such projects is crucial (Agrawal & Gibson 1999). Land types such as the lake and marshes were deemed to be more valuable than others because they were related to direct income or indirect but visible ecosystem services such as provision of water, important for both fish and rice production; for example, many primary school teachers in Alaotra perceive the Asian snakehead *Channa maculata*, an invasive fish species, as a tangible benefit (Reibelt et al. 2014). One factor that shaped the values and perceptions of local communities was distance to the resource. The nearest forest to Alaotra is 10–20 km away and interviewees did not consider it to be important because they had no direct access to the forest and consequently no direct benefit from it. Similar perceptions have been reported for resource users in the Manompana forest corridor (Urech et al. 2015).

Delivering conservation messages to large populations of resource users in countries such as Madagascar that lack basic infrastructure such as electricity and roads can be a challenge. Furthermore, conservation practitioners in the Alaotra region have questioned whether a single high-priority park such as Park Bandro is actually of value in terms of reaching conservation targets, or whether a number of interconnected protected areas would provide better protection for the lemurs and their marsh habitat. Our results indicate the importance of distance to a high-priority conservation area such as Park Bandro, and suggest it may be easier to increase local awareness of protected areas if a number of smaller high-priority community-managed protected areas were embedded within the larger New

Protected Area. At Lake Alaotra, fishers have a close relationship to the lake and marshes compared with other user groups interviewed. People are connected to the environment they live and work in. For some, the marshes represent a cultural heritage or unique biodiversity that gives the region prestige. For others, the marsh is a working environment necessary for survival. This demonstrates the dichotomy of conservation in Alaotra. People are culturally and socially attached to the marshes but they also need the land to cultivate and the fish to sustain the growing population. Regardless of their reasons for attachment to the environment, we found local people were willing to discuss zonation and resource management strategies. They understand that for fish stocks to be sustainable they require space (zones) and time (closed seasons) for fish to reproduce and recover (Wallace et al. 2016). However, in reality Alaotra is an example of the tragedy of the commons (Dietz et al. 2003): many people are ignoring the closed fishing season (November–January), putting further pressure on the common-pool resource, while professional fishers who respect the regulations see the fish stocks shrinking and are tempted to ignore regulations and exploit the diminishing resource (Copsey et al. 2009b). Unregulated immigration into the region to profit from this resource further aggravates the situation. Similarly, although people showed an understanding of the value of the marshes, lake and biodiversity, we found they perceived the main value of the marshes as being a place for work, echoing the idea of parks being 'a reservoir for the future society' (McNeely 2015). The challenge is therefore the reconciliation of a positive attitude towards an intact ecosystem with the need to generate income for local people.

If conservation activities provide tangible livelihood benefits there is a chance for conservation to succeed. However, the protection of resources with non-market-based values is difficult. The challenge from a conservation perspective remains to increase the attractiveness of protected species without encouraging their commercialization. Despite favourable attitudes toward resource conservation, formal protection in the form of Ramsar and New Protected Area designations and local community management of Park Bandro, exploitation of fishing grounds and agricultural expansion, at the cost of lemur habitat, continue. A primary reason for this is the lack of physical delimitation of the boundaries of the protected areas, as well as weak law enforcement. A network of small high-priority sites managed by local community associations may provide increased protection within the New Protected Area, as long as boundaries are clear and visible, and law enforcement is accountable and transparent. The challenge in

such a scenario is in maintaining a minimum degree of connectivity. Promoting permanent protection zones (such as Park Bandro) may be acceptable to local communities if they perceive tangible and direct benefits for livelihoods, while interview participants favoured closed fishing seasons and no-take zones. Improved management and protection of the natural resources of Lake Alaotra may benefit both local resource users and *H*. *alaotrensis* but before we 'talk biodiversity conservation' we first need to be ready to 'talk rice and fish'.

Community involvement is crucial (Reibelt & Nowack 2015) and it is important that conservation in Alaotra engages with all stakeholders, and foremost with the communities that depend directly on the lake and marshland systems, but this has been challenging in the past (Rendigs et al. 2015). A community is not a homogeneous entity but consists of various stakeholders, each with their own agendas and value systems (Berkes 2004). Conservation organizations need to work more closely with fishers, who know the marshes best and are also an integral part of a social landscape (Richard & Ratsirarson 2013), especially where local knowledge about valuable fishing grounds and nurseries needs to be identified during conservation planning.

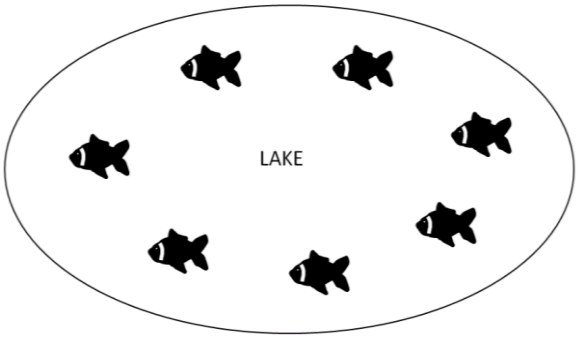
Increased stakeholder engagement in parallel with concerted habitat conservation efforts within the protected area should result in a better understanding of the purpose and the rules, including the boundaries, of Park Bandro. This requires that management roles and responsibilities are defined collaboratively, transparently and unambiguously among a complex group of stakeholders. The challenge is in developing a range of communication tools and strategies to discuss and administer protected areas most effectively with local resource users. Local community values and perceptions are invaluable, and our findings suggest there is room for conservation and improved resource use management within protected areas such as Lake Alaotra as long as this is balanced with the needs of the local community for food, water and income. There is hope that with improved protection and management Lake Alaotra's marsh and unique lemur can survive in an anthropogenically shared landscape.

3.6 Supplementary Material

Supplementary Material 3.1 Management options for Lake Alaotra fisheries. In Survey 2, 50 participants from the village adjacent to Park Bandro were asked for preferred management options for marshlands and fisheries. They were provided with the schemes below, showing three different fishery management options.

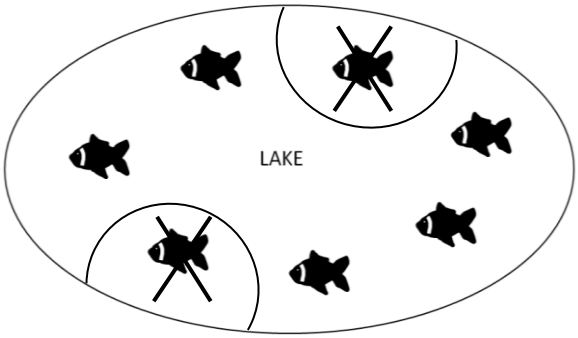
Option A:

free fishing year-round, i.e. without closed fishing seasons or permanent closed zones.



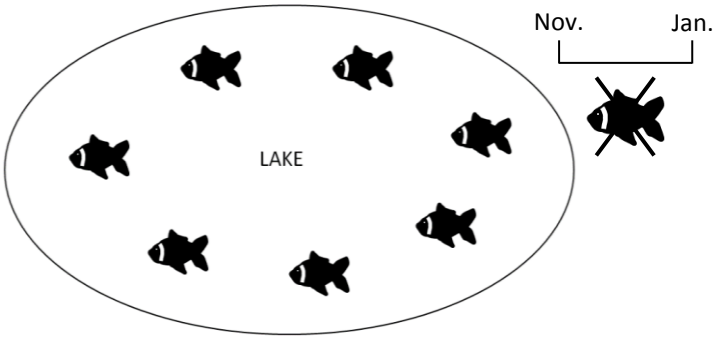
Option B:

without closed fishing seasons but with the establishment of permanent reserves where fishing is prohibited throughout the year.



Option C:

closed fishing season from November until January, a policy that is currently in place.

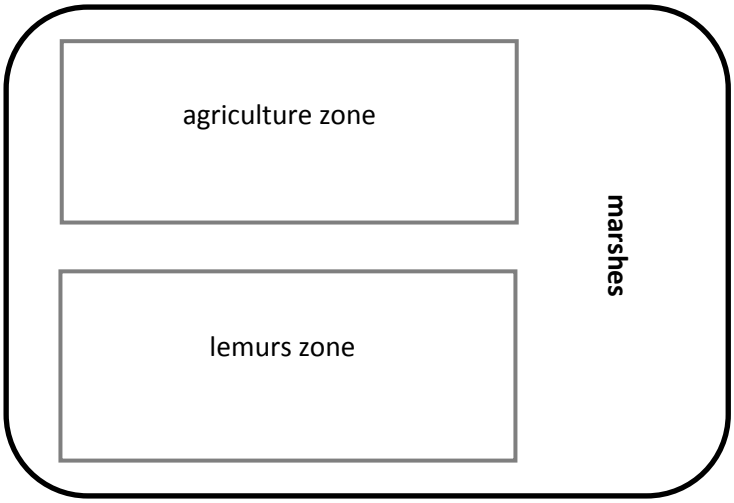


Supplementary Material 3.2 Management options for the marshes. In Survey 2, 50 participants from the village adjacent to Park Bandro were asked for preferred management options for marshlands. They were provided with the schemes below, showing two different marsh management strategies to choose from.

Option A:

distinct zoning for *H. alaotrensis* and agriculture

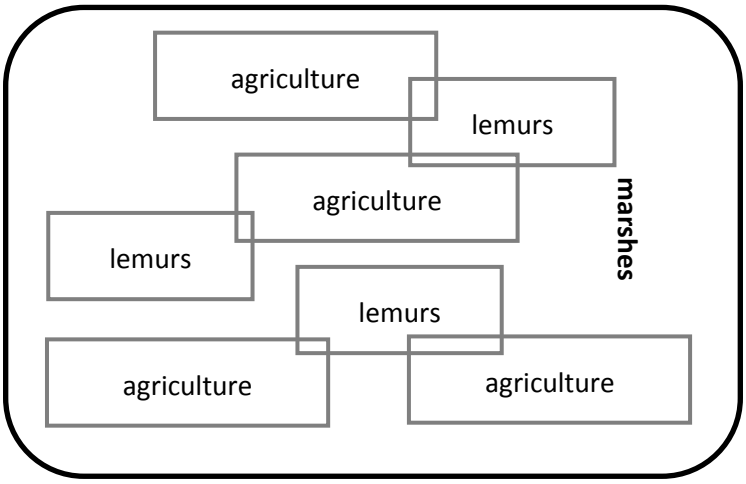
[land sparing]



Option B:

no zoning at all

[land sharing]



Chapter 4

Local people's perceptions of the Lake Alaotra gentle lemur

Abstract. Understanding factors which influence local community support for conservation projects is critical to their success. Perceptions of wildlife are particularly important in countries where people rely heavily on natural resources for their survival as is the case in Madagascar. Renowned as one of the "hottest" regions for global biodiversity, Madagascar hosts an exceptional assemblage of lemurs. Yet little is known concerning the knowledge and perceptions of local people toward lemurs. The Lake Alaotra gentle lemur (*Hapalemur alaotrensis*) is classified as Critically Endangered on the IUCN Red List and restricted to marsh habitat in the Lake Alaotra New Protected Area. Habitat destruction and hunting have brought the lemur to the brink of extinction. In this study, we characterize local people's knowledge, awareness, and perceptions of *Hapalemur alaotrensis*. We conducted an initial survey with 180 participants in six villages with varying distance to Park Bandro, a high-priority conservation zone. During a second survey, we interviewed 50 people in the village adjacent to the park. Our findings demonstrate that fishers are the most knowledgeable and most concerned local resource users despite lower education levels. There is a link between environmental awareness and distance in both a literal and figurative sense; the more often people encounter *Hapalemur alaotrensis*, the more they know about it, and the more likely they are to be concerned about its future. Our study further shows that despite this concern, subsistence is prioritized over conservation in the Alaotra region. Ecological knowledge in the fishers' communities is a valuable resource that can benefit the conservation of *Hapalemur alaotrensis* and its marshland habitat if conservation planning and management can align the resource users' concerns and livelihood needs with biodiversity values.

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4.1 Introduction

Linking conservation values with the livelihood needs of local communities is essential for any conservation strategy, particularly in a region where people rely heavily on natural resources for survival and income (Mehta & Kellert 1998, Salafsky & Wollenberg 2000, Nepal & Spiteri 2011, Nyaupane & Poudel 2011). Agrawal & Gibson (1999) demonstrated that local support for conservation projects was crucial and that conservation management would be more likely to be successful if the communities' perceptions and values were understood. Qualitative information gained from ethnographic studies provides valuable insights toward the understanding of conservation problems (Setchell et al. 2016) and is invaluable in ensuring the inclusion of local community concerns within conservation planning.

Madagascar, renowned as one of the "hottest" regions for global biodiversity (Myers et al. 2000, Ganzhorn et al. 2001), hosts an outstanding assemblage of primates (lemurs) found nowhere else in the world (Thalmann 2006, Mittermeier et al. 2008). The number of described lemur species has increased from less than 50 to more than 105 different taxa over the last two decades (Tattersall 2013, Waeber et al. 2015b) primarily due to increased efforts in field research and advancements in molecular biology. However, lemurs are increasingly threatened with extinction (Schwitzer et al. 2013). Little is known concerning the knowledge and perceptions of local people towards lemurs. While most lemur species are forest dwellers occupying a variety of forest types throughout Madagascar (Mittermeier et al. 2008), the Lake Alaotra gentle lemur (*Hapalemur alaotrensis,* known locally as bandro) is unique because of its restriction to the marshlands of the Lake Alaotra New Protected Area where it feeds on sedges (particularly *Cyperus* spp.), reeds; and grasses (Mutschler et al. 1998). *Hapalemur alaotrensis* is the only primate species in the world known to live exclusively within a marsh habitat (Waeber et al. in Press a, Waeber et al. in Press b). It is one of five extant species in the genus *Hapalemur* along with the southern bamboo lemur (*H. meridionalis*), northern bamboo lemur (*H. occidentalis*), lesser bamboo lemur (*H. griseus*), and the golden bamboo lemur (*H. aureus*; Mittermeier et al. 2014, Ballhorn et al. 2016). *Hapalemur alaotrensis* is classified as Critically Endangered on the IUCN Red List (Andriaholinirina et al. 2014). The species is at high risk of extinction due to a significant decline in population size and an ongoing reduction in area, extent and quality of marsh habitat at Lake Alaotra. The species has been

on a continuous decline since the first monitoring undertaken by Mutschler & Feistner (1995) who estimated 7500–11,000 individuals. Subsequent monitoring reported fewer than 2500 animals between 2003 (Ralainasolo 2004) and 2005 (Ralainasolo et al. 2006). Current numbers are assumed to be even less due to ongoing habitat loss (Ratsimbazafy et al. 2013). Although former intensive hunting pressure had declined (Mutschler et al. 2001, Andrianandrasana et al. 2005), increased marsh fragmentation and lack of local enforcement appears to have resulted in renewed poaching both for bush meat and the local pet trade. At the same time, marsh destruction continues unabated and presents a serious threat to the species survival (Ratsimbazafy et al. 2013, Waeber & Wilmé 2013).

Lake Alaotra is located in the eastern-central highlands of Madagascar, in the Alaotra-Mangoro Region (Figure 4.1). It is the largest lake in Madagascar covering some 20,000 hectares of open water, surrounded by 23,000 hectares of marshland (Andrianandrasana et al. 2005). The area is of high socio-economic importance as Madagascar's greatest producer of rice and fish (Ranarijaona 2007, Copsey et al. 2009b, Wallace et al. 2015). Human pressure on the ecosystem is high with more than 550,000 people living around the lake (INSTAT 2012). Marsh burning, draining, conversion to rice-fields and siltation from erosion of topsoil has reduced the marshes around Lake Alaotra to less than 25% of its historic 60,000–80,000ha levels (Bakoariniaina et al. 2006). Located at the south-eastern shore of the lake, Park Bandro is a small (originally 85 ha) protected area within the larger New Protected Area (Figure 4.1) that was established as a special conservation zone in 2004. The park is of high conservation importance as it hosts the biggest known sub-population of *Hapalemur alaotrensis* (Ratsimbazafy et al. 2013). It was created by the local VOI (*vondron' olona ifotony*, a local community association for natural resource management) from the nearby village of Andreba with support from the conservation organisations Durrell Wildlife Conservation Trust and Madagascar Wildlife Conservation. Durrell Wildlife Conservation Trust has been working in the region since the mid-1990s and Madagascar Wildlife Conservation has been present since 2003. Durrell Wildlife Conservation Trust has focused on creation of the Lake Alaotra New Protected Area and ecological monitoring (Andrianandrasana et al. 2005) supporting 90 local people carrying out weekly patrols in the marsh around the lake, while Madagascar Wildlife Conservation has focused on environmental education and ecotourism (Maminirina et al. 2006, Rendigs et al. 2015).

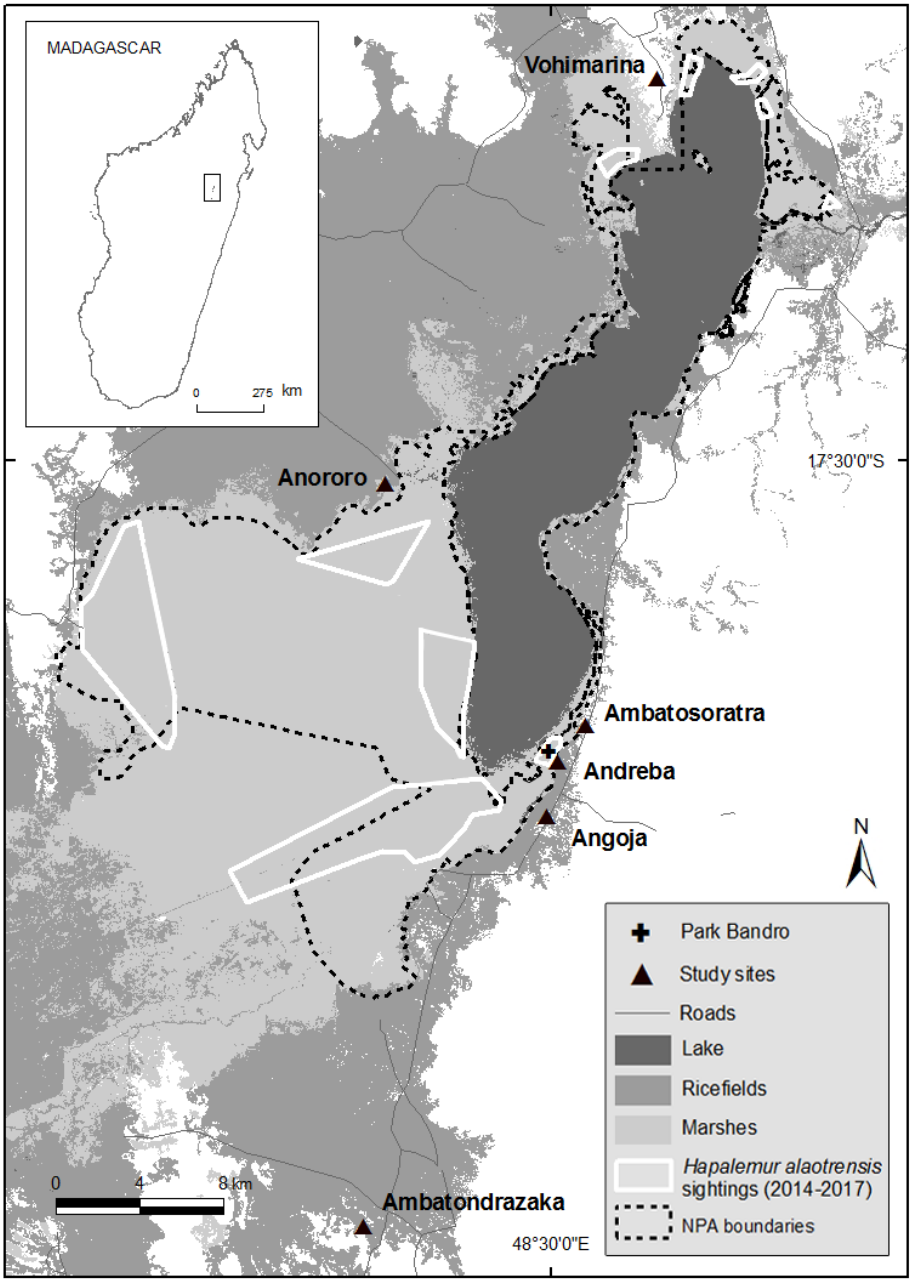


Figure 4.1 Lake Alaotra with surrounding marshes and rice fields. The map shows the Lake Alaotra New Protected Area (NPA) boundaries, the location of Park Bandro, and the six study sites. We recorded *Hapalemur alaotrensis* sightings since 2014 in three participatory mapping workshops with local experts in January 2017.

We developed the current research project to understand levels of environmental awareness and what lemurs mean to resource users around Lake Alaotra, specifically whether there were differences in levels of knowledge and concern among user groups and among villages located at varying distances from the high-priority conservation zone Park Bandro. With this explorative qualitative research, we characterize local people's knowledge and awareness of *Hapalemur alaotrensis*. We further explore their attitudes towards, and values concerning the lemur within the context of developing future environmental awareness and conservation management plans.

4.2 Methods

We carried out two questionnaire surveys in 2015 to examine local people's knowledge, awareness and perceptions of *Hapalemur alaotrensis*. Ethnographic experiences gained during previous studies (Ralainasolo 2004, Reibelt et al. 2014, Rakotoarisoa et al. 2015) and the composition of our research team (locals from various areas around Lake Alaotra) helped in questionnaire design, pre-testing, and data analysis. To examine differences in levels of awareness between sites and user groups we compared years of schooling between smaller, remote villages around the lake (Anororo, Vohimarina, Ambatosoratra, Andreba, Angoja) and the regional capital Ambatondrazaka, as well as between user groups. In July 2015 we carried out survey 1 and involved 180 participants from six sites around Lake Alaotra (Figure 4.1). We chose villages to represent varying distances from the community managed ecotourism and conservation area at Park Bandro near Andreba. In September of the same year, we interviewed 50 participants from Andreba in survey 2. We collected baseline data on the participants including their main livelihood activity in both surveys (Table 4.1).

Survey 1 focused on quantifying people's knowledge of *Hapalemur alaotrensis* at the scale of the entire lake. Questions focused on whether, when, where, and how many lemurs they had encountered. Survey 2 explored people's perceptions of the value of different animal types at Andreba, the village nearest to Park Bandro. We asked participants to rank wild and domestic animals according to importance and to provide the reasons for their ranking. Both surveys contained questions concerning the conservation value of *Hapalemur alaotrensis.*

We applied purposive sampling (Bernard 2006) by interviewing people at the lake, close to the marshland border, and along the main route between each village

market and the lake shores. We assumed that these people are natural resource users and that they influence or depend on the marsh and/or lake in some way. For the second survey we focused on people that we encountered along the border of the lake or marsh near Andreba to focus on direct resource users who earn their living by working on the lake or in the marsh. In both surveys we divided the interviews equally between morning, mid-day and evening. Participation was voluntary, and we informed all participants about the aims and scope of the research project before obtaining their consent to take part in the study. A small number of participants were 14-16 years old (Table 4.1). We treated these participants in the same manner as other age groups, as it is common for younger people to be engaged in livelihoods reliant on natural resource use and we did not want to exclude them from the survey.

Surveys were anonymous and administered in Malagasy by two local research assistants whom we trained before starting the data collection. A female research assistant presented the survey verbally, and a male assistant recorded responses, allowing for an open discussion-style interview. The open questions allowed participants to express knowledge and perceptions in their own words so that qualitative information was not lost (Drury et al. 2011, Setchell et al. 2016). We administered surveys over 1-4 days per site. Questionnaires contained open questions as well as ranking and yes/no questions. For open questions we conducted quantitative content analysis with inductive creation and establishment of categories (Lamnek 2005). We discussed and adapted the categories in an iterative process within the research team. During analysis, we calculated summary statistics including percentages of all answers. To test for differences between sites and between professions, we used Fisher's exact test, the t-test and the Wilcoxon rank-sum test using R versions 3.0.3 and R 3.2.1 (R Development Core Team 2015). Our research followed the principles outlined in the ethical code for research by Wilmé et al. (2016).

Table 4.1 Overview of participants of two surveys at six study sites at Lake Alaotra to determine local knowledge of the Lake Alaotra gentle lemur in 2015. PB refers to Park Bandro.

Site	Sample size	Region	Distance to PB [km]	Number of men/women	Age range [years]	Mean schooling [years]	Range of schooling [years]	Main livelihoods (top 3)
Survey 1								
Site 1	30	S	24.0	16/14	14–60	10.1	5-14	student; farming; housework
Site 2	30	W	14.7	24/6	16–67	7.3	4-12	fishing; weaving; farming
Site 3	30	N	32.4	17/13	15–75	6.9	1-12	farming; fishing; weaving
Site 4	30	E	2.1	26/4	18–60	5.8	1-10	fishing; farming; duck walking
Site 5	30	E	0.7	30/0	15–75	7.3	2-14	fishing; farming; student
Site 6	30	E	3.1	25/5	15–75	7.0	2-14	fishing; fish collection
All	180	---	---	138/42	14–75	7.4	1-14	fishing; farming; student
Survey 2								
Site 5	50	E	0.7	33/17	15–73	7.7	0-14	farming; fishing; student

4.3 Results

4.3.1 Survey participants

Of the 180 participants from the initial survey, median age was 35 years (mean 36, range 14-75), and the median years of schooling was 8 years (mean 7.4, range 1-14, Table 4.1). Participants from the city of Ambatondrazaka had significantly more years of schooling than any of the villages (two-sample t-tests with Bonferroni correction, all p-values <0.001; details in Supplementary Material 4.1, p.73). Of the 50 participants from survey 2 in Andreba, the median age was 37 (mean 38, range 15-73), and the median years of schooling was 8 years (mean 8, range 0-14 years; Table 4.1).

4.3.2 Local knowledge of *Hapalemur alaotrensis*

Of the 180 participants in the initial survey, 89% said that they knew of *Hapalemur alaotrensis*. When describing the lemur, 63% of the participants drew comparison with humans, cats, and other lemurs (Figure 4.2, Supplementary Material 4.10, p. 93). Sixty-one percent of those who knew of *Hapalemur alaotrensis* mentioned physical characteristics related to color, size, pelage, and body shape while 8% described the lemur's character as shy, gentle, or sympathetic (Supplementary Material 4.10). Twenty-four percent pointed out that *Hapalemur alaotrensis* has a diet based on marshland vegetation, including mentions of specific vegetation such as reeds (11%) and sedges (*Cyperus* spp.; 9%).

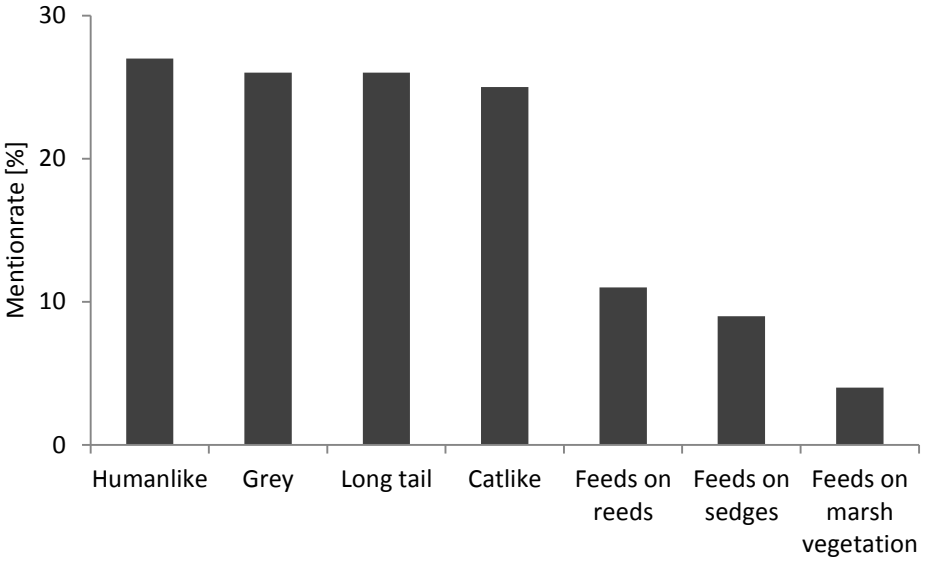


Figure 4.2 The most common responses to 'What do you know about *Hapalemur alaotrensis*, called bandro?' in survey 1 (n=180) at Lake Alaotra in 2015. Percentages are from the 'Yes' subsample of 160 people who knew the lemur (89% of total sample). Overall, participants gave a range of 1-6 answers, with a mean of 2 (median=2). See Supplementary Material 4.8, p. 81 for a complete list of descriptions of the lemur.

When we asked participants whether they knew where *Hapalemur alaotrensis* lived, 83% said yes, and 17% didn't know. Of the participants, 83% replied that the lemur lived in Madagascar, and of these, 13% said this lemur lived throughout the Alaotra region while others (87%) cited specific sites or villages around the lake. Of the 180 participants, 81% stated that *Hapalemur alaotrensis* lives in the marshes, while 2% wrongly referred to the open landscape and 1% mentioned forest. Significantly more fishers knew where *Hapalemur alaotrensis* lived (n=94; 90% of fishers) when compared to non-fishers (n=55; 72% of non-fishers; Fisher's exact test, 95% confidence interval [0.110, 0.676], odds ratio: 0.281, p=0.002; Supplementary Material 4.4, p. 88). When asked for information about personal encounters with *Hapalemur alaotrensis*, 86% of participants answered they had seen the lemur at some point during their life, with no significant difference between the six study sites (Supplementary Material 4.8, p. 91). Of these, 20% had seen the lemur in Park Bandro, 70% in the marshes outside of the park, and 10% in captivity (Figure 4.3). These differences in lemur sighting locations between sites were significant between the regional capital of Ambatondrazaka

and the villages of Anororo and Andreba (closest to Park Bandro), and also between Anororo and Vohimarina (Fisher's exact test with Monte Carlo simulation, all p<0.001; Supplementary Material 4.8, p. 91). Respondents from Ambatondrazaka stated that they had either seen *Hapalemur alaotrensis* in the marshes outside Park Bandro (55%) or in captivity (45%), while in Andreba, 69% of people surveyed had seen lemurs outside of Park Bandro compared to 31% within the park. None of the people interviewed from Andreba reported having seen *Hapalemur alaotrensis* in captivity. Fifty-eight percent of the respondents in Ambatondrazaka had last seen a *Hapalemur alaotrensis* more than a year ago, compared to a sighting during the last six months for 58% of the people interviewed at Andreba (Fisher's exact test with Monte Carlo simulation, p=0.003; Supplementary Material 4.8, p. 91).

Of the 160 respondents who knew *Hapalemur alaotrensis* (Figure 4.2), 61% were fishers and 39% were non-fishers, and significantly more fishers knew of *H. alaotrensis* than non-fishers (Fisher's exact test, 95% confidence interval [0.082, 0.805], odds ratio: 0.273, p=0.015; Supplementary Material 4.4, p. 88).

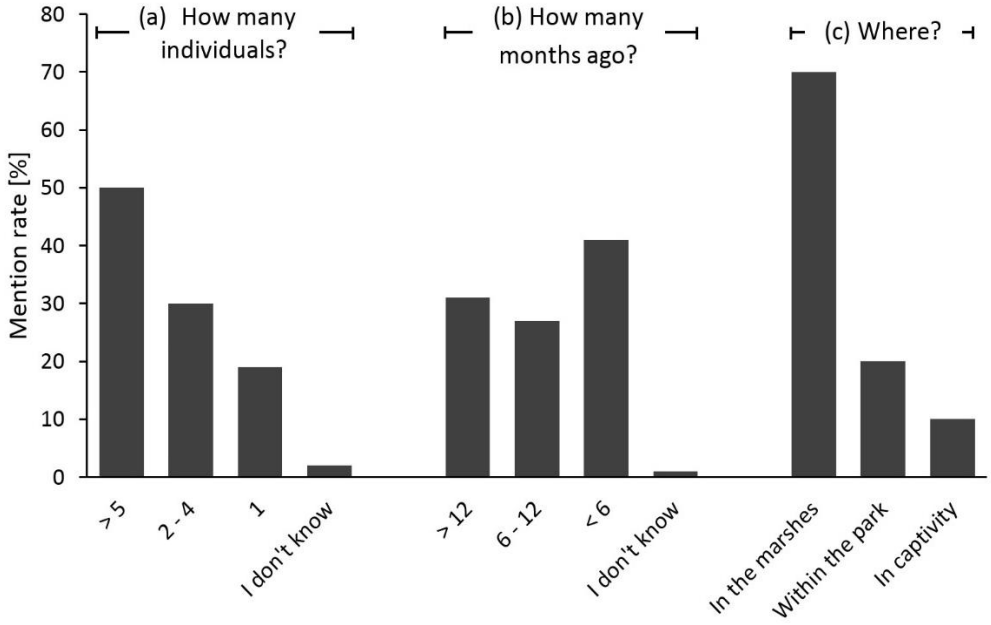


Figure 4.3 *Hapalemur alaotrensis* sightings reported by local people at six study sites around Lake Alaotra during Survey 1 (n=180) in 2015. Percentages are from the 'Yes' subsample of 155 people who had already seen the lemur (86% of total sample).

4.3.3 Local perceptions of and values concerning *Hapalemur alaotrensis*

When we asked participants to provide three open statements that best described what *Hapalemur alaotrensis* meant to them, the most common answers were that the lemur "lives in the marshes", "feeds on marsh vegetation", and is "catlike". Other common replies were that the lemur "attracts tourists", is a "mammal", and is a "richness for the region" (Table 4.2).

Table 4.2 The most common replies to 'What is *Hapalemur alaotrensis*, called bandro for you?' of local people (n=50) surveyed at Andreba in 2015. We asked each participant to provide three answers.

Reply	**No. of mentions**	**Percentage**
Lives in the marshes	45	90
Feeds on marsh vegetation	23	46
Catlike	12	24
Humanlike	9	18
Attracts tourists	8	16
Mammal	8	16
Richness for the region	5	10
Endangered species	4	8
Peculiar species	4	8
Endemic species	4	8
Owns the marshes	3	6
Provides prestige	3	6
Wildlife	3	6
Protected species	2	4
Primate species	2	4
Cultural heritage	1	2
God's creation	1	2
Prohibited to keep in captivity	1	2
Source of income	1	2
Forbidden to hunt	1	2
Puppylike	1	2

When we asked people whether they were personally affected by a decline in lemur numbers (survey 1, n=180), 64% of participants said they were concerned while 20% said they were not concerned.

Significantly more fishers than non-fishers were concerned by the decline in number of lemurs (Fisher's exact test, 95% confidence interval [0.171, 0.909], odds ratio: 0.397, p=0.019, Supplementary Material 4.4, p. 88; Figure 4.4). The sites with the highest concern were Ambatosoratra, Andreba and Angoja, and those with the least concern were Anororo and Vohimarina (Fisher's exact test with a Bonferroni correction; all p <0.003, Supplementary Material 4.9, p. 92; Figure 4.5).

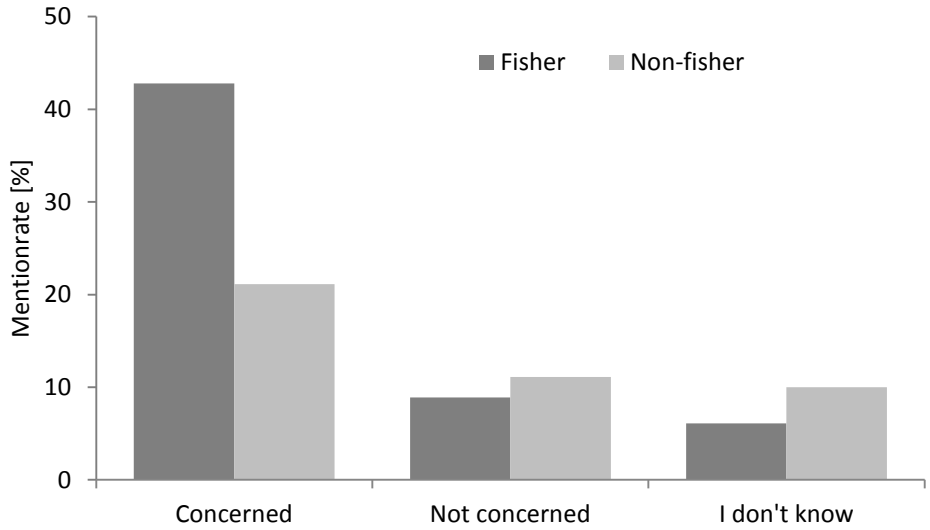


Figure 4.4 Answers to 'Are you concerned about the population declines in *Hapalemur alaotrensis*?' Differences in concern among fishers and non-fishers in survey 1 (n=180) at Lake Alaotra in 2015.

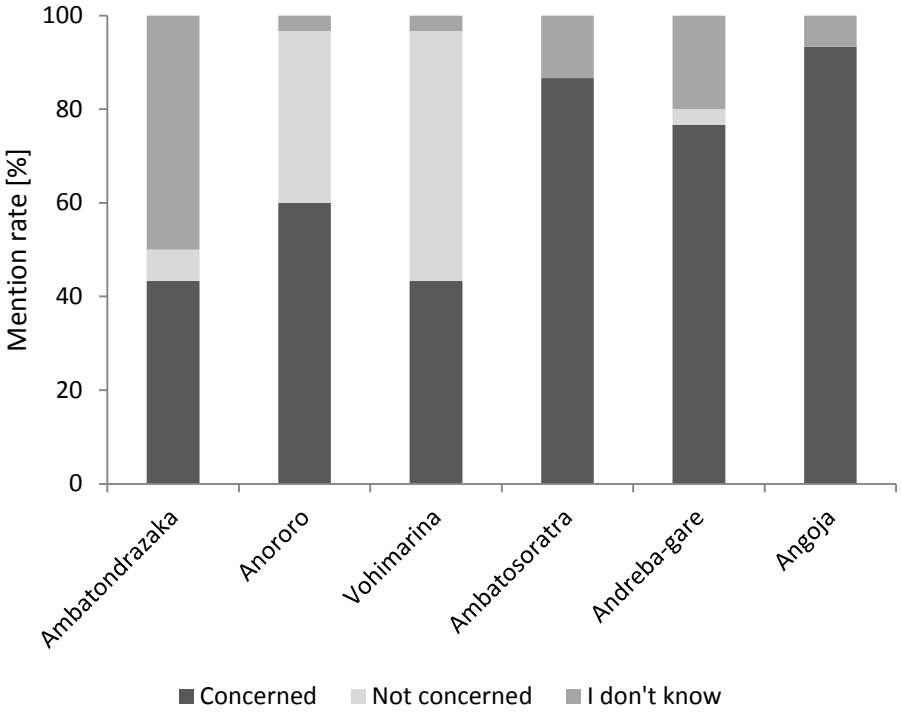


Figure 4.5 Answers to 'Are you concerned about the population declines in *Hapalemur alaotrensis*?' Differences in concern between villages surveyed in survey 1 (n=180) at Lake Alaotra in 2015.

The most common reasons cited for being concerned about population declines were "bandro could go extinct", "bandro is humanlike", and "loss of richness" (Table 4.3). Other reasons were "loss of prestige", "environmental destruction", "loss of pleasure", "marsh destruction" and "no tourism". For those people that were not concerned, the two reasons cited were "it's not important" and "the decline is a myth".

Table 4.3 Answers to 'Why are you concerned about the population declines in *Hapalemur alaotrensis*?' Reasons cited by local people (n=115) during surveys conducted at six villages around Lake Alaotra in 2015. Percentages are from the 'Yes' subsample of 115 persons who had expressed concern (64% of total sample).

Reason for concern	**No. of mentions**	**Percentage**
Bandro could go extinct	48	42
Bandro is humanlike	23	20
Loss of richness	14	12
Loss of prestige	5	4
Environmental destruction	5	4
Loss of pleasure (in seeing the lemur)	4	4
Marsh destruction	3	3
No tourism	3	3
Accustomed to seeing the lemur	1	1
Environment and conservation	1	1
Loss of a gentle animal	1	1
Loss of income	1	1
No disadvantage to the lemur being there	1	1
Loss of the lemur makes me unhappy	1	1
I don't know	4	4

When looking at the four closed questions regarding the lemur that could be answered with a 'Yes' or 'No', we summarized the number of 'Yes' answers to build a composite variable for awareness and concern. The composite variable was negatively correlated with distance to Park Bandro (Kendall correlation: $z=-4.165$, $p<0.001$, $tau=-0.26$; Figure 4.6), in other words more people from sites near Park Bandro were aware of and concerned about *Hapalemur alaotrensis* than in villages further away. Years of schooling did not have a significant effect on the composite variable (we compared more vs. less than mean years of schooling >/= 8 years vs. < 8 years, with a Wilcoxon rank sum test: $W=4410$, $p=0.092$).

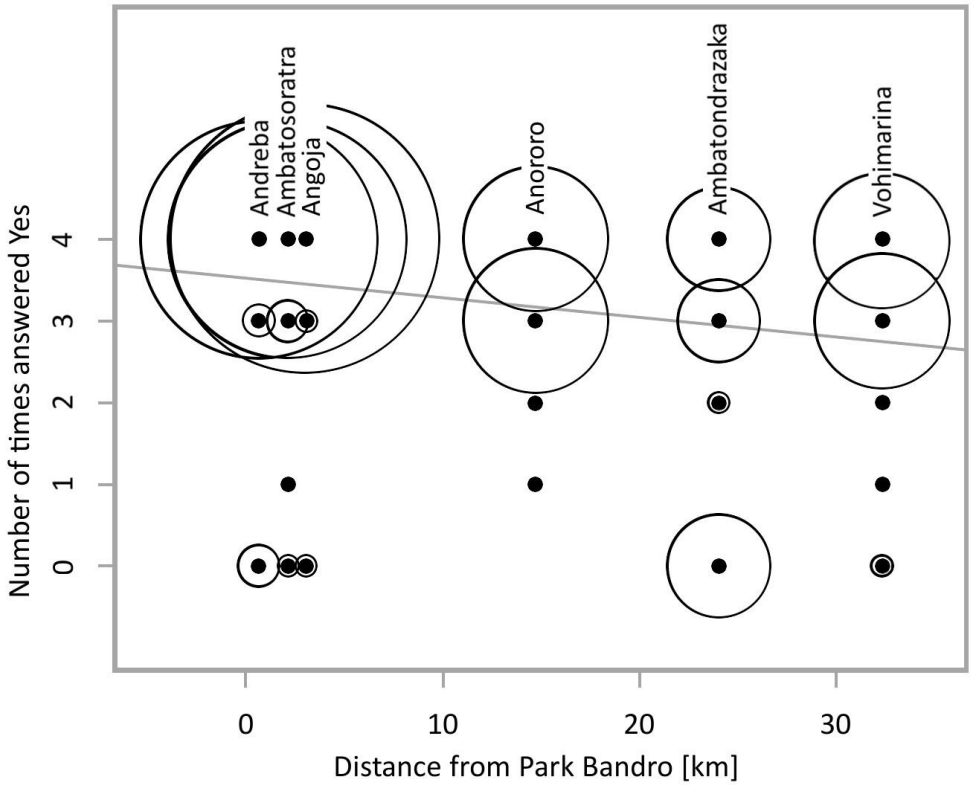


Figure 4.6 The relationship between distance of a village to Park Bandro and a composite variable measuring awareness/knowledge of *Hapalemur alaotrensis* based on surveys carried out at Lake Alaotra in 2015. The composite variable includes all closed questions regarding *Hapalemur alaotrensis* (answerable either 'Yes' or 'No'; Supplementary Material 4.11, p. 94). The size of the bubbles indicates how many people answered Yes at the respective distance/ study site.

The ranking of wild and domestic animals revealed that the study participants considered zebu and fish to be the most important, followed by pigs and chickens. Study participants ranked *Hapalemur alaotrensis* and ducks (domestic and wild) as least important (Figure 4.7). The most common reasons for a high ranking were linked to income (e.g., fish) and usefulness (e.g., zebu as working tool) while interviewees justified the lowest ranking for wild ducks by being "difficult to hunt" and "forbidden to hunt". For *Hapalemur alaotrensis*, the explanations for the least important ranking were that it is a "protected species" and "forbidden to hunt" (Table 4.4).

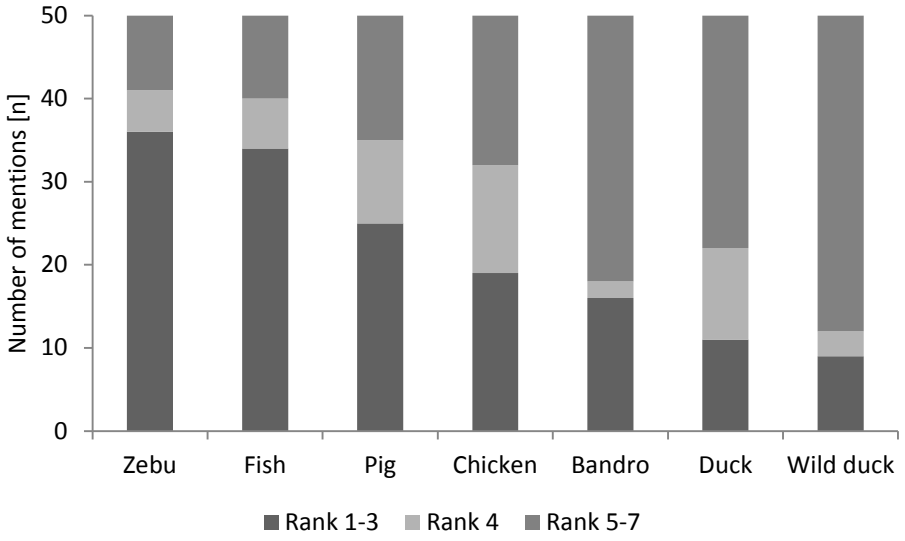


Figure 4.7 Ranking of animals by importance (1=very important to 7=not important at all) by 50 participants from the village of Andreba in 2015. We summarized ranks 1-3 and 5-7 for simplicity; see Supplementary Material 4.13, p. 96 for a detailed breakdown of rankings.

Table 4.4 The most common reasons provided for value rankings of animal types by local people at the village of Andreba in 2015.

	Reasons: ranked least important	**Reasons: ranked most important**
Zebu	Too expensive	Working tool, source of income
Fish	Impossible to breed	Source of income, subsistence
Pig	Expensive to keep, destroys cultivation	Source of income
Chicken	No direct benefit, common animal	Source of income, can be bred
Bandro	Protected species, forbidden to hunt	Prestige, endangered species
Duck	Difficult to breed	Source of income, easy to feed
Wild duck	Difficult to hunt, forbidden to hunt	---

4.4 Discussion

Encouragingly, 89% of the people we surveyed around Lake Alaotra were aware of the existence of *Hapalemur alaotrensis*. Most participants could describe the lemur's appearance, but fewer than half of the respondents could provide more detailed characteristics such as its diet. Years of schooling did not have a significant influence on levels of awareness and knowledge of *Hapalemur alaotrensis.* To the contrary, fishers exhibited the highest levels of knowledge and awareness despite having the lowest educational levels. Awareness and knowledge of participants from the city of Ambatondrazaka were lower than that of participants in the smaller, remote villages around the lake, although participants from the city had the highest levels of schooling. This supports findings by Reibelt et al. (2014) that the local natural environment is usually not addressed in primary schools in the region, a situation replicated throughout Madagascar (Ratsimbazafy 2003, Dolins et al. 2010, Reibelt et al. 2017a).

A majority (86%) of the people we surveyed had seen *Hapalemur alaotrensis* at some time during their lives. This is likely representative of people living at or working on the border of, or close to, and in the marshes and highlights local communities' reliance on the marshes. Participants from all the surveyed villages had seen lemurs in the marshes, mainly in groups of 2–4 or more animals. This shows that there still are patches of quality habitat for *Hapalemur alaotrensis* outside Park Bandro, and it is critical to protect and reconnect such key areas of marsh habitat to ensure the species' survival in the long-term.

Although 64% of respondents were concerned with the decline of *Hapalemur alaotrensis*, some felt that the decline was unimportant while others believed that its decline is a myth. Real life experiences shape environmental attitudes, and are believed to be stronger than indirect experiences such as specific programs or learning in school aiming to change attitudes (Rajecki 1982, Newhouse 1990). This should be considered when shaping educational interventions. If local resource users learn or are told by non-governmental organizations and educators that *Hapalemur alaotrensis* is highly threatened, but encounter animals on a regular basis in their environment due to the species being locally common in small fragments, they may not believe other messages from conservation organizations. This pattern seems to be confirmed in Andreba where lemur encounters are most common due to the proximity to Park Bandro. No participants from this site explained their concern about *Hapalemur alaotrensis* with the species' risk of

extinction while 42% of all survey participants did. People in general are attached to the environments they live and work in and can provide information on wildlife in these areas (Gandiwa 2012). In the Alaotra region, the marshes are a cultural heritage and its unique biodiversity creates prestige for the region. For many local people the marshes are a working environment needed for survival (Waeber et al. 2017). Positive experiences in the natural environment lead to environmental awareness and concern (Chawla 1998b), but in settings where people's dependency on natural resources is high, the experience of loss and degradation of their environment can also lead to increased concern (Korhonen & Lappalainen 2004).

Our results demonstrate that fishers were the most knowledgeable local resource users and were more concerned about the decline and possible extinction of *Hapalemur alaotrensis* than non-fishers. Fishers are in the marshes and on the lake daily, and appear to have an intimate link to these ecosystems. Their experiences and frequent contact with wildlife have increased their awareness of the species' existence and shaped positive attitudes towards them. We recommend further studies to explore in more detail the knowledge and perceptions of the various stakeholder groups, given that most inhabitants of the Alaotra region rely on several professions to pursue their livelihoods (Rakotoarisoa et al. 2015).

While fishers can be a valuable stakeholder in lemur conservation at Lake Alaotra, the extent to which different resource users, including fishers, are involved in lemur hunting at Alaotra is unclear. Trapping of *Hapalemur alaotrensis* was a major concern at Alaotra in the 1990s (Mutschler et al. 2001) and while this has declined significantly in recent years due to conservation efforts, there is anecdotal evidence that lemur trapping has begun to rise again with increased marsh fragmentation. Rapid social change leading to the degradation of historical taboos has resulted in an escalation in lemur hunting for bushmeat throughout Madagascar (Jenkins et al. 2011, Golden 2009, Reuter et al. 2016). Gardner & Davies (2014) found that bushmeat collection was primarily carried out opportunistically by people entering the forest for other reasons, rather than by specialist hunters. During the current study, 10% of people surveyed stated that they had seen *Hapalemur alaotrensis* in captivity at some point during their life, although there was a major difference between the city of Ambatondrazaka and Andreba, the village closest to Park Bandro. Forty-five percent of people surveyed

in the city had seen *Hapalemur alaotrensis* in captivity compared to 0% in Andreba. To better understand dynamics among user groups and potential risks linked to poaching, we recommend that research be carried out at Alaotra to determine the typology of poachers, motivations and the extent of collection of *Hapalemur alaotrensis*. The literature review by Muth & Bowe Jr (1998) may provide a useful heuristic framework for empirical studies in the Alaotra, while this knowledge can then be incorporated within regional lemur conservation and environmental education programs.

We found a link between environmental knowledge, awareness, and concern, with distance in both a literal and figurative sense. The more often people encounter *Hapalemur alaotrensis*, the more they know about it, and the more likely they are to be concerned about its future. This is most obvious in the sites Andreba, Ambatosoratra, and Angoja which are the three closest to the park, where highest lemur densities occur. In the city (Ambatondrazaka), where people have the highest educational levels but no direct access to the marsh, people know the least about *Hapalemur alaotrensis*. Half of the interviewees in the city replied 'I don't know' when asked whether they were concerned about population decline of *Hapalemur alaotrensis*, suggesting that they have a weak relation to the lemur. In Anororo and Vohimarina, despite similar knowledge levels to the other villages, about half of the interviewees said they were not concerned about the declining numbers of the lemur. It is not clear whether this is related to fewer lemur encounters in their marshes, to social tensions between pro and contra conservation groups in these villages, or to other factors.

Waeber et al. (2017) reported a strong negative effect of distance on local peoples' awareness levels of the high-priority conservation zone Park Bandro, which can be explained by the fact that Park Bandro is a single site, whereas lemur encounters as in the current study are possible throughout the marshes surrounding Lake Alaotra. Studies elsewhere have also reported a significant influence of distance on awareness of and attitudes toward wildlife and other natural resources. At Manompana in eastern Madagascar, interest in the preservation of forest fragments was related to walking distance between people's homes and forest resources (Urech et al. 2012). People closer to forest fragments were more appreciative of the benefits provided by those fragments. In Kenya, proximity to a national reserve significantly increased positive attitudes toward conservation of the reserve in community members (Shibia 2010).

Similarly, distance was a significant factor in explaining knowledge and perceptions of residents concerning two creeks in Texas, USA (Brody et al. 2004). In contrast, studies in Ecuador (Fiallo & Jacobson 1995) and Botswana (Parry & Campbell 1992) found increasingly negative attitudes with decreasing distance to protected areas. Negative attitudes were primarily based on the perceived negative influence of animals foraging on crops, land-use restrictions, and loss of land or livestock. Similar negative attitudes and perceptions were reported in various studies in settings with human-wildlife conflicts (e.g., Oli et al. 1994, Hill 1998, Lee & Priston 2005, Hill & Webber 2010). These different findings suggest that contact with wildlife can shape attitudes and perceptions both positively and negatively, depending on the nature of the experience. Neither Park Bandro nor *Hapalemur alaotrensis* carry negative connotations, likely because they are not perceived to have a restrictive impact on the primary natural resource uses of residents around Lake Alaotra. This is similar to the attitudes of local residents toward black howler monkeys (*Alouatta nigra*) and a conservation sanctuary for their protection in Belize (Alexander 2000). Local people supported the conservation of the howler monkey and its habitat but also stated that there was no negative impact on their lives associated with the sanctuary.

The fact that distance to Park Bandro also influences awareness of the *lemur*, and not only on knowledge and awareness of *Park Bandro* (Waeber et al. 2017) may be due to the increased conservation efforts and awareness raising campaigns by conservation organizations such as Madagascar Wildlife Conservation and the Durrell Wildlife Conservation Trust who have focused much of their environmental awareness and education work around Park Bandro. At the same time this highlights a challenge in undeveloped and economically depressed areas like Madagascar where infrastructure and means of communication are poorly developed. It suggests that communication tools that are more effective in reaching wider areas need to be prioritized around Lake Alaotra, for example communication outreach workshops targeting specific segments of a society (Steinmetz et al. 2014).

Fish and zebu cattle were identified as culturally, socially and economically significant. Fish is an important source of income and zebu are valuable working animals for agriculture and transport. Animals that provided direct benefits for subsistence, economic (e.g., fish) and/or social well-being (e.g., zebu which also represent social prestige; Kaufmann & Tsirahamba 2006) ranked the highest.

Hapalemur alaotrensis and waterfowl (wild and domestic ducks) ranked lowest in terms of value, as they are either under protection and illegal to hunt, or they are difficult to catch or breed. The low ranking of *Hapalemur alaotrensis* suggests that the creation of Park Bandro as an ecotourism site where visitors can stay and pay to observe the lemur in the marshes has not provided a sense of economic importance of the lemur to people in Andreba. This may be because tourist numbers are too low to be economically significant (Rendigs et al. 2015) and it can also be challenging to understand how benefits from ecotourism interact with other economic, social and cultural values (Waylen et al. 2009). Local people at Alaotra appear to prioritize direct livelihood benefits over conservation values. For example, despite the negative ecological impact of the invasive fish *Channa maculata* (Copsey et al. 2009a), primary school teachers in the Alaotra region did not perceive this to be an environmental problem, because it provided a source of food (Reibelt et al. 2014). Unless conservation and sustainable development projects ensure more than a minimal and short-termed socioeconomic benefit, local people in areas with high levels of rural poverty will be unable to change their way of living (Marcus 2001).

Since the political crisis in Madagascar in 2009, the conversion of marshlands has been accelerated by wealthy and powerful nonlocal individuals that do not rely on local resources for survival. This has been facilitated by the vulnerability of the rural poor to follow illegal activities on behalf of these powerful individuals that are mostly based in the big cities (Ratsimbazafy et al. 2013, Waeber & Wilmé 2013), low levels of law enforcement, and the lack of formal legal protection for the marshes prior to the permanent status granted for the Lake Alaotra New Protected Area in June 2015. The combination of these factors has brought *Hapalemur alaotrensis* to the brink of extinction. However, the concern for the future of *Hapalemur alaotrensis* in villages around Lake Alaotra is encouraging and local people are also willing to discuss conservation zones, as long as areas are designated where they can pursue their daily livelihood activities such as fishing or rice farming (Waeber et al. 2017). Fishers, in particular, preferred clear and effectively managed zoning for the benefit of resource users and biodiversity, including *Hapalemur alaotrensis*. Fishers prefer many, small no-take zones that correspond with important fish spawning areas (Wallace et al. 2015, Wallace et al. 2016), confirming their awareness of the links between marsh vegetation, fish reproduction, and livelihood benefits to the fisher communities at Lake Alaotra. In Zambia, as awareness of the consequences of environmental degradation on

livelihoods increased, so too did the likelihood of behavioral change by small-scale farmers to reduce the degradation (Wu & Mweemba 2010). This suggests that awareness raising and educational campaigns should target specific groups in the communities around Lake Alaotra, such as farmers, to increase the collective readiness to respect conservation areas and change behaviour. Increased contact with nature led to increased positive attitudes towards nature in children (increased biophilia and decreased biophobia) and biophilia significantly influenced their willingness for animal conservation in China (Zhang et al. 2014). Moreover, in line with the city-villages divide suggested by our study, children in urban areas had less biophilia and less readiness for conservation than most children from rural areas with more nature contact (Zhang et al. 2014).

The fact that local people are willing to discuss conservation zonation at Lake Alaotra provides hope for the future conservation of *Hapalemur alaotrensis*. However, conservation and development organizations need to ensure alignment between resource management planning and local community needs to avoid a disconnection between conservation policy and community needs. Such a disconnection has reduced the effectiveness of large scale and long-term international and nation-wide conservation and development efforts in Madagascar in the past (Waeber et al. 2016). Restricting local livelihood needs also increases the risk of human-wildlife conflicts which could facilitate a shift towards negative perceptions of wildlife, and conservation in general.

Our findings for Lake Alaotra can also inform conservation in other regions of Madagascar. However, conservation planning is context-dependent and it is important not to simplify cultural aspects (Keller 2009). Nevertheless, taboos can have important impacts on local perceptions and attitudes in Madagascar and are different from region to region (e.g., Ramanantsoa et al. 1984, Mittermeier et al. 1994, Lingard et al. 2003, Rakotomamonjy et al. 2015).

While based on a modest sample size of 230 participants, our study identified trends in local community knowledge, awareness, and perceptions of *Hapalemur alaotrensis*. We found differences between fishers and non-fishers and a negative correlation between levels of knowledge and distance from the high-priority conservation zone Park Bandro. People that encountered the lemur most often showed the highest levels of awareness and concern for the lemur's future. Qualitative research examining people's perceptions and priorities should be expanded at Lake Alaotra beyond fishers and farmers to provide further evidence

of trends in conservation attitudes amongst a wider group of stakeholders. Community values, perceptions, and knowledge of *Hapalemur alaotrensis* should be used to guide future conservation planning, environmental education and livelihood improvement activities at Lake Alaotra. The marshes and the Lake Alaotra gentle lemur can only be protected if local resource users are part of the solution and conservation and development organizations utilize information gained through qualitative studies to align resource users' concerns and livelihood needs with biodiversity values.

4.5 Supplementary Material

Supplementary Material 4.1 Differences in years of schooling between the six study sites. We used a two sample t-test with Bonferroni correction to counteract the problem of multiple comparisons; the significance level for these cases is 0.003.

Site comparison	t-value	DF	p-value
Ambatondrazaka vs. Anororo	3.858	51.86	<0.001
Ambatondrazaka vs. Vohimarina	7.064	56.48	<0.001
Ambatondrazaka vs. Ambatosoratra	4.914	56.36	<0.001
Ambatondrazaka vs. Andreba	4.679	51.32	<0.001
Ambatondrazaka vs. Angoja	4.299	54.88	<0.001
Anororo vs. Vohimarina	-0.570	54.35	0.571
Anororo vs. Ambatosoratra	0.507	55.86	0.614
Anororo vs. Andreba	-1.576	52.68	0.121
Anororo vs. Angoja	0.052	54.98	0.958
Vohimarina vs. Ambatosoratra	-0.015	55.60	0.988
Vohimarina vs. Andreba	-2.289	55.42	0.026
Vohimarina vs. Angoja	-0.546	56.96	0.587
Ambatosoratra vs. Andreba	2.044	53.50	0.046
Ambatosoratra vs. Angoja	0.480	56.09	0.633
Andreba vs. Angoja	-1.727	56.67	0.090

Supplementary Material 4.2 Differences in age between the six study sites. We used the two sample t-test with Bonferroni correction to counteract the problem of multiple comparisons; the significance level for these cases is 0.003.

Site comparison	t-value	DF	p-value
Ambatondrazaka vs. Anororo	-3.112	56.79	0.003
Ambatondrazaka vs. Vohimarina	-4.137	57.88	<0.001
Ambatondrazaka vs. Ambatosoratra	-2.528	56.16	0.014
Ambatondrazaka vs. Andreba	-1.997	56.44	0.051
Ambatondrazaka vs. Angoja	-1.389	45.54	0.172
Anororo vs. Vohimarina	-0.786	57.42	0.435
Anororo vs. Ambatosoratra	-0.613	56.97	0.542
Anororo vs. Andreba	-1.498	53.07	0.140
Anororo vs. Angoja	-2.464	41.84	0.018
Vohimarina vs. Ambatosoratra	-1.448	56.66	0.153
Vohimarina vs. Andreba	-2.508	55.54	0.015
Vohimarina vs. Angoja	-3.704	44.32	<0.001
Ambatosoratra vs. Andreba	0.833	52.74	0.408
Ambatosoratra vs. Angoja	1.757	41.44	0.086
Andreba vs. Angoja	1.0086	50.32	0.318

Supplementary Material 4.3 Differences in gender composition between the six study sites. We used the Fisher's Exact Test (overall p<0.001). The significance level is set at 0.05 except for the single tests where we used Bonferroni correction to counteract the problem of multiple comparisons; the significance level for these cases is 0.003.

Site comparison	Odds Ratio	95% CI	p-value
Ambatondrazaka vs. Anororo	0.876	0.280 - 2.722	1.000
Ambatondrazaka vs. Vohimarina	0.292	0.075 - 1.018	0.054
Ambatondrazaka vs. Ambatosoratra	0.000	0.000 - 0.194	<0.001
Ambatondrazaka vs. Andreba	0.181	0.037 - 0.709	0.010
Ambatondrazaka vs. Angoja	0.235	0.055 - 0.857	0.025
Anororo vs. Vohimarina	0.333	0.085 - 1.170	0.095
Anororo vs. Ambatosoratra	Inf	4.504 - Inf	<0.001
Anororo vs. Andreba	4.835	1.227 - 23.859	0.020
Anororo vs. Angoja	3.736	1.015 - 15.988	0.047
Vohimarina vs. Ambatosoratra	Inf	1.303 - Inf	0.024
Vohimarina vs. Andreba	1.612	0.335 - 8.762	0.731
Vohimarina vs. Angoja	1.245	0.275 - 5.905	1.000
Ambatosoratra vs. Andreba	Inf	0.689 - Inf	0.112
Ambatosoratra vs. Angoja	Inf	0.983 - Inf	0.052
Andreba vs. Angoja	1.294	0.247 - 7.319	1.000

Supplementary Material 4.4 Differences between fishers and non-fishers concerning the various questionnaire answers. We used the Fisher's Exact Test for count data, and the t-test for continuous data. *H.a.* stands for *Hapalemur alaotrensis*.

Question	Test	Odds Ratio	95% CI	p-value
Do you know *H.a.*?	Fisher's Exact Test	0.273	0.082 - 0.805	0.015
Have you seen *H.a.*?	Fisher's Exact Test	0.357	0.130 - 0.923	0.028
Where did you see *H.a.*?	Fisher's Exact Test	NA	NA	0.019
When did you see *H.a.*?	Fisher's Exact Test	NA	NA	0.008
How many individuals of *H.a.*?	Fisher's Exact Test	NA	NA	0.003
Do you know where *H.a.* lives?	Fisher's Exact Test	0.281	0.110 - 0.676	0.002
Are you worried about *H.a.* decline?	Fisher's Exact Test	0.397	0.171 - 0.909	0.019

Supplementary Material 4.5 Differences between fishers and non-fishers concerning gender, age, and years of schooling. We used the Fisher's Exact Test for count data, and the t-test for continuous data.

Question	Test	Test Statistic	DF	Odds Ratio	95% CI	p-value
Gender	Fisher's Exact Test	---	---	0.148	0.059 - 0.342	<0.001
Age	t-test	T = -0.517	137.04	---	-5.021 - 2.941	0.606
Schooling	t-test	T = 3.966	156.87	---	0.863 - 2.577	<0.001

Supplementary Material 4.6 Differences between the six study sites regarding the question 'Do you know *Hapalemur alaotrensis* / the bandro?'. We used the Fisher's Exact Test (overall p=0.002). The significance level is set at 0.05 except for the single tests where we used Bonferroni correction to counteract the problem of multiple comparisons; the significance level for these cases is 0.003

Site comparison	Odds Ratio	95% CI	p-value
Ambatondrazaka vs. Anororo	0.147	0.0142 - 0.800	0.021
Ambatondrazaka vs. Vohimarina	0.000	0.000-0.347	0.001
Ambatondrazaka vs. Ambatosoratra	0.314	0.062 - 1.291	0.125
Ambatondrazaka vs. Andreba	0.147	0.0142 - 0.800	0.021
Ambatondrazaka vs. Angoja	0.147	0.0142 - 0.800	0.021
Anororo vs. Vohimarina	0.000	0.000 – 5.296	0.492
Anororo vs. Ambatosoratra	0.470	0.039 – 3.600	0.671
Anororo vs. Andreba	1.000	0.068 - 14.692	1.000
Anororo vs. Angoja	1.000	0.068 - 14.692	1.000
Vohimarina vs. Ambatosoratra	0.000	0.000 – 1.347	0.048
Vohimarina vs. Andreba	0.000	0.000 – 5.296	0.492
Vohimarina vs. Angoja	0.000	0.000 – 5.296	0.492
Ambatosoratra vs. Andreba	0.470	0.039 - 3.600	0.671
Ambatosoratra vs. Angoja	0.470	0.039 - 3.600	0.671
Andreba vs. Angoja	1.000	0.068 - 14.692	1.000

Supplementary Material 4.7 Differences between the six study sites regarding the question 'Do you know where the bandro lives?' . We used the Fisher's Exact Test (overall p<0.001); for single tests with Bonferroni correction.

Site comparison	Odds Ratio	95% CI	p-value
Ambatondrazaka vs. Anororo	0.116	0.018 - 0.499	0.002
Ambatondrazaka vs. Vohimarina	0.036	0.001 - 0.278	<0.001
Ambatondrazaka vs. Ambatosoratra	0.159	0.032 - 0.619	0.005
Ambatondrazaka vs. Andreba	0.256	0.066 - 0.888	0.029
Ambatondrazaka vs. Angoja	0.075	0.007 - 0.386	<0.001
Anororo vs. Vohimarina	0.316	0.006 - 4.211	0.612
Anororo vs. Ambatosoratra	0.726	0.097 - 4.753	1.000
Anororo vs. Andreba	0.450	0.066 - 2.390	0.472
Anororo vs. Angoja	2.127	0.278 - 25.388	0.671
Vohimarina vs. Ambatosoratra	0.212	0.004 - 2.331	0.187
Vohimarina vs. Andreba	0.142	0.003 - 1.294	0.103
Vohimarina vs. Angoja	0.488	0.008 - 9.878	1.000
Ambatosoratra vs. Andreba	1.612	0.335 - 8.762	0.731
Ambatosoratra vs. Angoja	0.470	0.039 - 3.600	0.671
Andreba vs. Angoja	0.291	0.026 - 1.828	0.254

Supplementary Material 4.8 Differences between the six study sites regarding the questions (i) 'Did you see a *Hapalemur alaotrensis*/ bandro?' and (ii) 'Where, when, and how many bandro did you see?'. We used a Fisher's Exact Test to calculate the overall p-value, and used Monte Carlo simulation for post-hoc tests to estimate p-values, including a Bonferroni correction to counteract the problem of multiple comparisons; the significance level for these cases is 0.003. The Fisher's Exact Test for (i) was not significant (p=0.063), so we did not conduct post-hoc tests for this question.

Site comparison	(a) Where did you see a bandro? (overall p<0.001)	(b) When did you see a bandro? (overall p=0.089)	(c) How many bandro did you see? (overall p=0.011)
Ambatondrazaka vs. Anororo	0.008	0.046	0.210
Ambatondrazaka vs. Vohimarina	<0.001	0.037	0.004
Ambatondrazaka vs. Ambatosoratra	<0.001	0.003	0.003
Ambatondrazaka vs. Andreba	0.004	0.072	0.002
Ambatondrazaka vs. Angoja	0.008	0.021	0.149
Anororo vs. Vohimarina	<0.001	0.938	0.224
Anororo vs. Ambatosoratra	0.013	0.551	0.174
Anororo vs. Andreba	0.859	0.465	0.195
Anororo vs. Angoja	0.135	0.941	1.000
Vohimarina vs. Ambatosoratra	0.285	0.594	0.417
Vohimarina vs. Andreba	0.006	0.717	0.714
Vohimarina vs. Angoja	0.056	0.707	0.212
Ambatosoratra vs. Andreba	0.083	0.207	0.915
Ambatosoratra vs. Angoja	0.282	0.591	0.121
Andreba vs. Angoja	0.595	0.188	0.172

Supplementary Material 4.9 Differences between the six study sites regarding the question 'Are you concerned about bandro decline?'. We used the Fisher's Exact Test with Bonferroni correction.

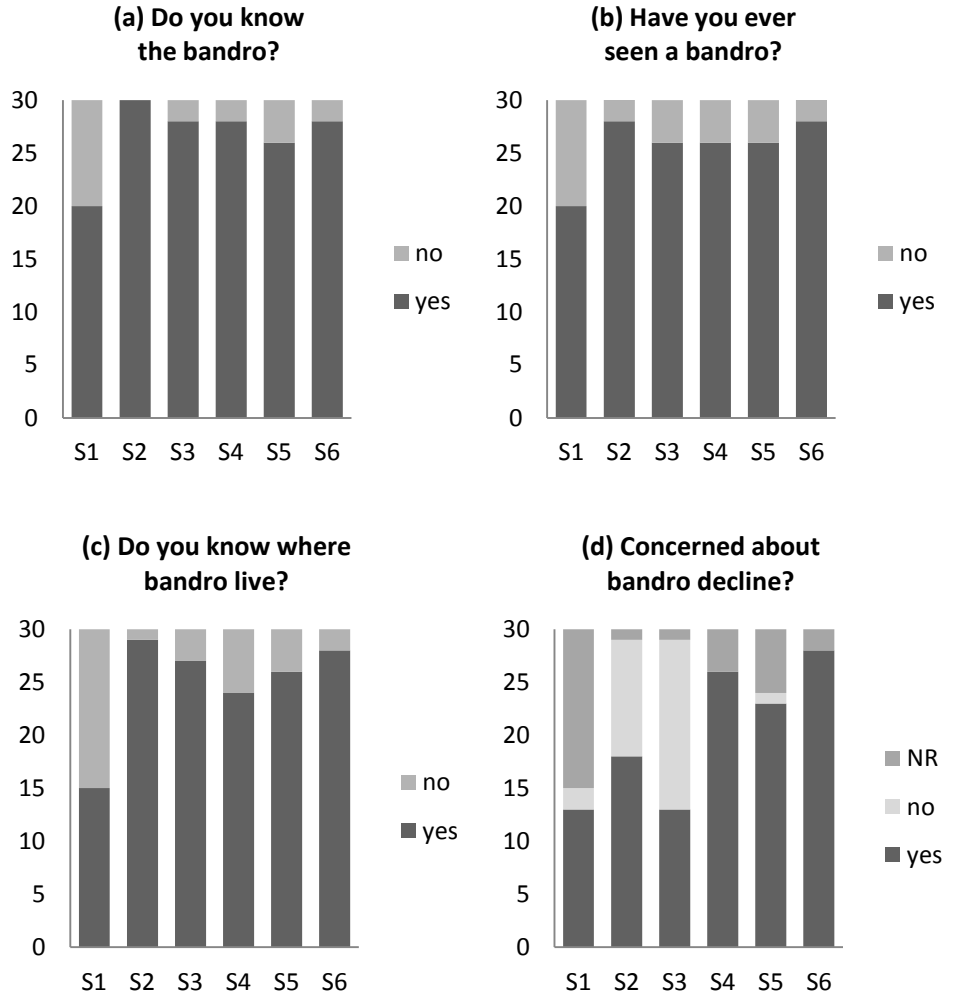
Site comparison	Odds Ratio	95% CI	p-value
Ambatondrazaka vs. Anororo	7.636	1.353 - 81.635	0.010
Ambatondrazaka vs. Vohimarina	4.445	0.774 - 47.792	0.089
Ambatondrazaka vs. Ambatosoratra	0.292	0.005 - 6.121	0.547
Ambatondrazaka vs. Andreba	0.000	0.000 - 2.100	0.128
Ambatondrazaka vs. Angoja	0.000	0.000 - 2.783	0.116
Anororo vs. Vohimarina	0.579	0.178 - 1.829	0.431
Anororo vs. Ambatosoratra	26.623	3.411 -1228.46	<0.001
Anororo vs. Andreba	Inf	6.163 - Inf	<0.001
Anororo vs. Angoja	Inf	6.663 - Inf	<0.001
Vohimarina vs. Ambatosoratra	15.509	1.952 - 720.602	0.003
Vohimarina vs. Andreba	Inf	3.539 - Inf	<0.001
Vohimarina vs. Angoja	Inf	3.826 - Inf	<0.001
Ambatosoratra vs. Andreba	0.000	0.000 - 36.000	0.48
Ambatosoratra vs. Angoja	0.000	0.000 - 33.429	0.462
Andreba vs. Angoja	0.000	0.000 - Inf	1.000

Supplementary Material 4.10 Details of descriptions of *Hapalemur alaotrensis* cited by participants that stated they knew of the lemur (see also Supplementary Material 4.2, p. 86); survey data from six villages around Lake Alaotra in 2015 (n=160).

Descriptions	Mentions [%]	Descriptions (continued)	Mentions [%] (continued)
Features	**63**	**Ears**	**6**
humanlike	27	rounded ears	4
catlike	25	little ears	1
lemur-like	7	little long ears	1
like *varika*[1]	3	**Body**	**6**
like *indri*[2]	1	size	6
doglike	1	small	4
Color	**61**	round face	1
grey	26	long face	1
black	24	long leg	1
brown	4	long arms	1
black and white	1	long hip	1
clear color	1	four legs	1
nice color	1	hairy	1
yellow	1	with arms	1
beige	1	with hands and tail	1
black when young	1	4 cm length	1
brown-black	1	little size	1
purple when old	1	small monkey	1
Tail	**30**	**Other**	**35**
long tail	26	group-living	19
with tail	3	jumps	4
little tail	1	mammal	4
Eyes	**19**	lemurs	3
red eyes	11	have many babies	1
big round eyes	8	carries baby on back	1
Character	**8**	die alone in old age	1
shy	4	endemic	1
gentle	3	Knows how to live with humans	1
sympathetic	2		
clean	1	hunted by humans	1
wise	1	monogamous	1
can bite	1	take care of their children	1
not shy	1		

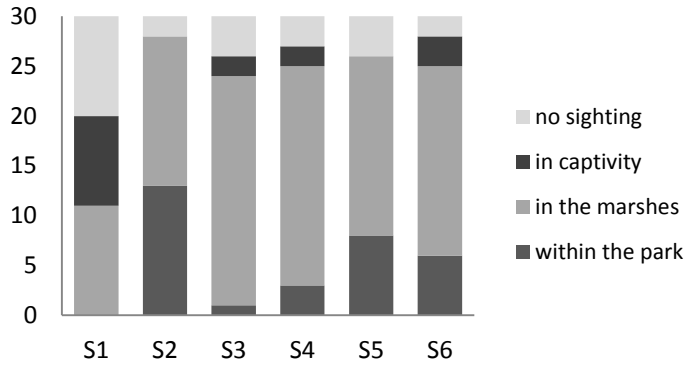
[1] 'varika' is Malagasy for the brown lemur (*Eulemur fulvus*); [2] 'indri' is Malagasy for the indri (*Indri indri*)

Supplementary Material 4.11 Overview of the answers to the questions regarding *Hapalemur alaotrensis* that could be answered either Yes or No; survey data from the six villages Site 1-Ambatondrazaka, S2-Anororo, S3-Vohimarina, S4-Ambatosoratra, S5-Andreba, and S6-Angoja (n=180).

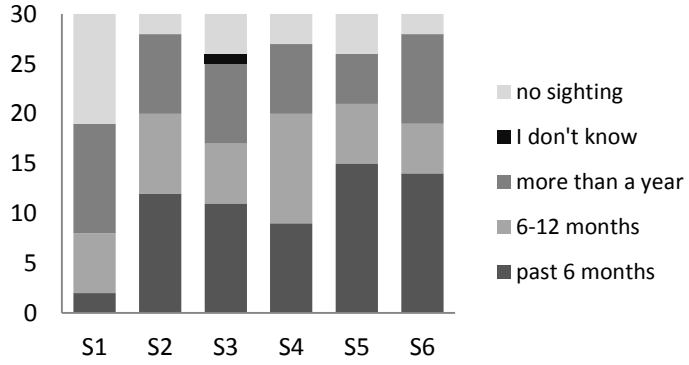


Supplementary Material 4.12 Overview of the answers to the closed questions regarding *Hapalemur alaotrensis*; survey data from the six villages Site 1-Ambatondrazaka, S2-Anororo, S3-Vohimarina, S4-Ambatosoratra, S5-Andreba, and S6-Angoja (n=180).

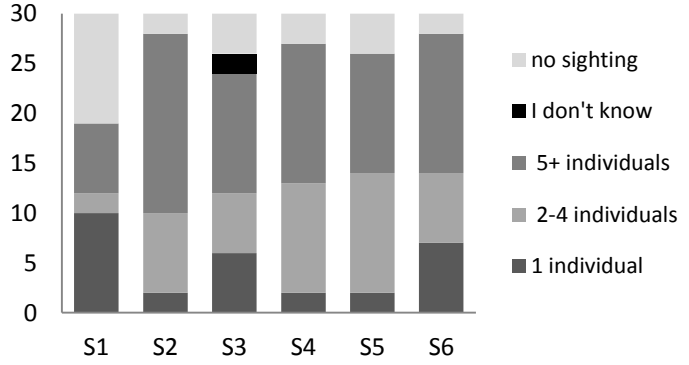
(e) Where did you see the bandro?



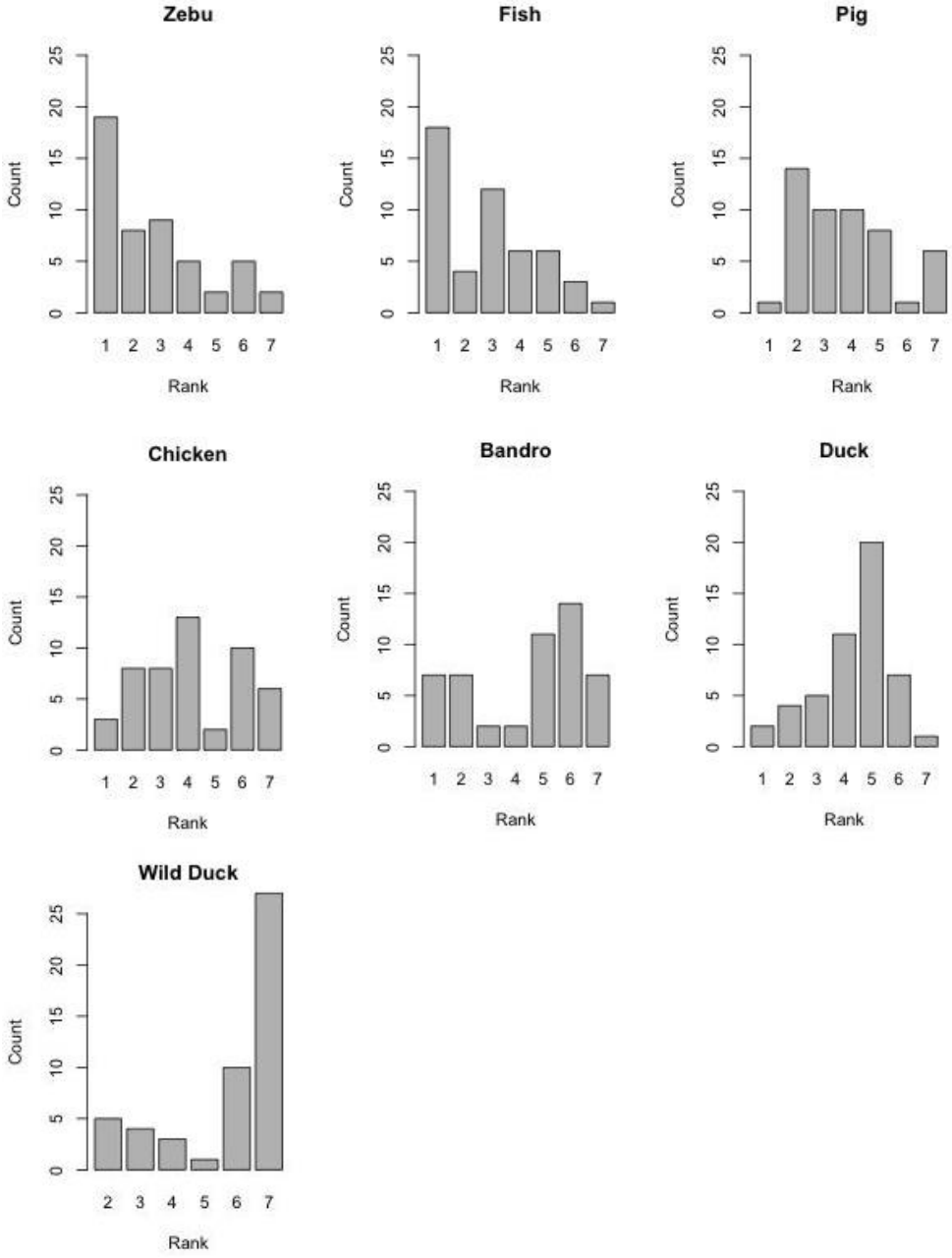
(f) When did you see the bandro?



(g) How many bandro did you see?



Supplementary Material 4.13 Detailed breakdown of rankings of animals by importance (1=very important to 7=not important at all) by the 50 participants from the village of Andreba in 2015. The graphs were produced using the hist command from the graphics library in R 3.2.1.



Chapter 5

Status quo of primary schools, teachers, and (environmental) education

Abstract. Madagascar is renowned for its unique biodiversity but also for the continuous degradation of its natural environment and its high poverty rate. In order to achieve sustainable development, environmental education has been assigned a key role. In the lake Alaotra region, Madagascar's most important rice and inland fish production area, primary schools are the sole formal education for the majority of the population. In order to gain an overview on the education of 'tomorrow's' resource users, this study assessed the general state of the school system and of environmental education in particular. The focus was on understanding local definitions of environmental education, its application and local perceptions of environmental problems. Over 50 in-depth interviews were conducted using the Funnel approach with teachers from 18 public primary schools. The interviews were supplemented with focus groups and a participatory problem analysis workshop. Teachers in the Alaotra region provided a different definition of environmental education than the United Nations. Their focus is on social aspects rather than the actual problems of the natural environment, which represents a different point of view than non-governmental organizations (NGOs) from abroad, who are the main promoters of environmental education in the area. This indicates that education for sustainable development might be more suitable in the region than the currently promoted environmental education. When developing educational programs, it is important to include the teachers in the development processes to ensure inclusion of local views and needs. This will increase the probability that such programs are locally meaningful and useful.

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5.1 Introduction

5.1.1 Environmental education

Environmental education became globally recognized some 40 years ago (Palmer 2002) and today comprises all efforts that help individuals or societies to develop the necessary skills to enable informed decisions and actions to improve the environment. The objectives of environmental education were defined and refined during the international environmental workshop in Belgrade, Yugoslavia (UNESCO 1975, 1976) and the first international inter-governmental conference on environmental education in Tbilisi, Georgia (UNESCO 1978). The objectives of environmental education are to help groups and individuals to develop (i) 'awareness' towards the environment and environmental problems, (ii) 'knowledge' and a basic understanding of the environment, its ecosystem functions and services, and linked problems, (iii) positive 'attitudes' and concern for the environment and the motivation for active participation of individuals and societies in environmental improvement and protection, (iv) 'skills' for identifying and solving environmental problems, and (v) 'participation', i.e., being actively involved in solving environmental problems (UNESCO 1976, 1978).

Agenda 21 (the global action plan towards sustainable development adopted at the UN Conference on Environment and Development held in Rio de Janeiro, Brazil, in 1992) points out the crucial role of education for reaching sustainable development, declaring it to be "critical for achieving environmental and ethical awareness, values and attitudes, skills and behavior" (UNCED 1992: 320). People educated in this way will be capable to understand environmental and development issues and to act accordingly, thus allowing public participation in decision-making and ensuring sustainable development in the long-run (ibid). The UNESCO states that "educators are one of the most important levers to realize educational change and to facilitate learning for sustainable development" (UNESCO 2013: 2).

5.1.2 Environmental education and sustainable development

The concept of sustainable development was first recognized in the World Conservation Strategy (IUCN 1980), and reached fame with the Brundtland Report "Our common future" seven years later where sustainable development was defined as "meeting the needs of the present without compromising the ability of

future generations to meet their needs" (WCED 1987: 43). The Report applied a global view on the links between environmental and socio-economic issues, as well as future well-being for humanity; considering an economic, social and political perspective. It expressed human's dependency on the environment as well as local, regional, national and global linkage and interdependency of ecology and economy (WCED 1987: 5). Education has been assigned a key role in achieving the global aim of sustainable development (IUCN 1980). The fourth international conference on environmental education, Tbilisiplus30 dealt with the arising question how to bridge the gap between environmental education and education for sustainable development and set a global agenda for the 'UN Decade of Education for Sustainable Development' for the period 2005 to 2014 (Combes 2005, Liimatainen 2013) in order to establish an essential contribution to human development**.**

While environmental education focusses on the amelioration of the environment with no close link to development, education for sustainable development is concerned about the human beings, linking environmental and developmental issues (Pavlova 2011). According to Agenda 21, "Education, including formal education, public awareness and training should be recognized as a process by which human beings and societies can reach their fullest potential. Education is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues" (UNCED 1992: 320). There is, however, a discrepancy in the interpretation of the two paradigms of environmental education and education for sustainable development (McKeown & Hopkins 2003); some countries use these concepts interchangeably, while others see the first as part of the second, or vice versa (Pavlova 2011).

The UNESCO proposal for the Global Action Programme (follow-up for the 'UN Decade of Education for Sustainable Development' after 2014) applies the term 'education for sustainable development' for all activities that will promote such evolution, "irrespective of whether they themselves use the term ESD or (depending on their history, cultural context or specific priority areas) environmental education, sustainability education, global education, development education, or other" (UNESCO 2013: 2).

5.1.3 The Madagascar context

A growing challenge in many developing countries is the reconciliation of a continuously increasing demand for agricultural products while conserving biodiversity, maintaining ecological functions and providing critical ecosystem services to sustain local livelihoods (Harvey et al. 2008, Brussaard et al. 2010). Madagascar, despite having received considerable international conservation and development attention in the past decades (Horning 2008), is still one of the poorest countries (UNDP 2013) while facing continuous degradation of its natural environment and an ongoing loss of its unique biodiversity.

The Human Development Index (HDI), calculated by the United Nations Development Programme (UNDP), is an alternative measure to the better known Gross Domestic Product (GDP) to assess a country's development state, which is measured by achievements in the dimensions of life expectancy, education, and available resources for living. Education is especially important as a stepping stone towards improved health; according to the UNDP, "a mother's education is more important to her child's survival than is household income or wealth" (UNDP 2013: 89). Madagascar with a HDI of 0.483 ranks 151 out of 187, figuring in the 'low human development group' together with many other African countries (UNDP 2013). It has globally one of the highest population growths rates (3%) and one of the lowest median ages of 18.2. This is paralleled by an extremely high primary school dropout rate of 65.4% (in comparison, total sub-Saharan Africa is at 37.8%, countries from the 'very high human development' group oscillate around 3.8%) leaving the majority of Madagascar's population without any secondary or tertiary education. Mean years of schooling in Madagascar are at 5.2, opposed to 11.5 in countries with high HDI, but still better than in Sub-Saharan Africa with 4.7 (ibid).

Madagascar is at great risk of increasing vulnerability and degradation due to overexploitation and climate change (Hannah et al. 2008, Shepherd et al. 2013); the 2030s-projections of vulnerability to climatic extremes and disasters even put Madagascar into the globally highest risk group due to its increasing poverty (Shepherd et al. 2013). Education is crucial to acquire further competences needed to deal with threats in the future (Muttarak & Lutz 2014). This begs the question whether the current school system is capable to shoulder this responsibility?

5.1.4 Education in Madagascar

Madagascar had one of the first Sub-Saharan African school systems during the Merina Kings and Queens period with formal schools mainly in the central highlands around Antananarivo, targeting the noble classes (*andraina*) only (Antal & Ndrianjafy 2013). With the French colonialists, the formal school system started to reach more remote areas in Madagascar. The education system in Madagascar was modeled based on the French system: *maternelle*, *collège*, and *lycée* with the *baccalauréat* exam at the end, and option to continue at university level (Sharp 2002). The Malagasy school system continued to mimic the French one also after Madagascar's independence (1960) and lasted until 1972, marking the end of the First Republic under President Philibert Tsiranana (Randrianja & Ellis 2009).

The period of 'rebelling' began in 1972 when a nationalist movement demanded the end of 'neo-colonialism', leading to the fall of the Tsiranana regime and the creation of a transitional government responsible for the introduction of the *malgachisation* of teaching (ibid). A socialist revolution led to the Second Republic under President Didier Ratsiraka, who adopted and furthered the *malgachisation* beyond the education system (Johnson 2006). Ratsiraka introduced the official Malagasy language, which was based on the Merina dialect from the central highlands. As a consequence, many non-Merina teachers speaking different dialects, and who had received all of their previous education and training in French, struggled to suddenly use exclusively the new official language (Sharp 2002). The promotion and propagation of new schools by the socialist regime led to a lack of well trained teachers, but also a lack of financial resources impeded the new government to target the country's 11,000 *fokontany*, especially in more rural areas. Parents often had to collect money to contribute or pay the salaries of the teachers or to provide teaching equipment such as textbooks or furniture (Johnson 2006). The lack of Malagasy teaching textbooks forced many teachers to translate the French textbooks into Malagasy. Consequently, little Malagasy culture was actually taught in schools (Sharp 2002).

With the installment of the Third Republic in 1992 under President Albert Zafy, many policies were reversed again, and French was reinstalled to assure quality in teaching and education. According to (Johnson 2006) however, the problem was now a lack of teachers being able to speak and teach in French, since many teachers serving under the First Republic had in the meantime been retired. Another recurring problem was the lack of French written textbooks. The Forth

Republic of President Marc Ravalomanana was a period of 'policy borrowing' (cf. Johnson 2006) to improve the school system by looking at other countries' systems. English as third official language was also introduced as third school language in primary schools. Ravalomanana invested in the building of thousands of new primary schools, and delivering also free basic material to students. During the years 1997–2007, the number of school inscriptions at primary level went up from 82% to 100%; while during 2000–2006, the number of repeaters went down from 30% to 18% (MENRS 2008). According to Randrianja (2012a), these improvements were due to efforts of parents associations or FRAM supporting teachers' salaries, therefore contributing significantly to the increase of number of teachers (especially ENFs, i.e., community-recruited teachers). The political crisis (2009–2013) resulted in many parents struggling to survive and not being able to support the ENFs (ibid). To date, Madagascar, as many developing countries, has a "dual-track system, with the well-off attending good schools and universities, mostly privately funded, and the poor attending inadequate, mostly publicly funded facilities" (UNDP 2013: 31, cf. Glick & Sahn 2006).

5.1.5 The Alaotra context

The primary economic driver in the Alaotra region is based on fisheries and rice production (Andrianandrasana et al. 2005, Monographie régionale 2012). The human population of Amparafaravola and Ambatondrazaka, the two lake districts of the Alaotra-Mangoro region, has increased from some 110,000 people in the 1960s to over 550,000 in 2011 (INSTAT 2012). A majority of people are rice cultivators, fishermen, vegetable farmers or cattle breeders, or occupy different professions at the same time to support their livelihoods (Rakotoarisoa et al. In press).

High population growth and changes in the ecological state of Lake Alaotra are linked with declining ecosystem services (Pidgeon 1996, Lammers et al. 2015). The remaining wetland system is exposed to increasing pressures, and overexploitation causes decreasing productivity (Raharijaona-Raharison & Randrianarison 1999) potentially leading to a lose-lose scenario, i.e., a downward spiral of poverty and environmental degradation as described by Sunderlin et al. (2005). To counteract this resource dependency and depletion, non-governmental organizations (NGOs) such as Durrell Wildlife Conservation Trust (Durrell) have been working in the region for more than 20 years. A case study done by Durrell

has shown a positive correlation between education and environmental awareness (Andrianandrasana et al. 2005). The Madagascar Wildlife Conservation (MWC) found increased knowledge for environmental issues in school children after participation in the environmental education program (Dolins et al. 2010, Rendigs et al. 2015). MWC has been running this program since 2006 and developed culturally and regionally adapted posters and comic books for the region to be used in public primary schools by trained teachers (Maminirina et al. 2006).

The goal of this study is to assess the state of environmental education in the Alaotra primary public schools. It is assumed that significant numbers of future resource users can be reached if environmental education is implemented on primary school level. Environmental education can strengthen conservation efforts such as maintaining ecosystem functions and biodiversity by contributing to improved awareness of and appreciation for the natural environment. Assessing the current situation is the first step in developing suitable and regionally adapted environmental education programs. Such education is hypothesized to advance sustainable development. This paper has two main objectives: (i) to understand the perceptions of 'environment' and 'environmental education' at primary schools at the teacher level, and (ii) to describe the school structure in terms of readiness for environmental education.

5.2 Methodology

A total of 18 primary schools around Lake Alaotra were selected based on the following criteria: (i) Public primary school; (ii) adjacency to the lake and remaining marshes; and (iii) accessibility, i.e., vicinity to *Routes Nationales* 3 and 44 (east and west coast of the lake, respectively).

Structured one-on-one interviews with 54 teachers (including 18 school directors) were conducted. Half of the interviewees were selected based on participant' lists of former MWC trainings and the other half were randomly sampled teachers without such training. A standardized interview guide according to the Funnel approach (cf. Wittkowski 1994) has been developed in order to avoid a social desirability bias (Paulhus 1991). Interviewers using the Funnel approach start with broader subjects and gradually narrow down their topics of interest, thereby masking the motivations of the interviewers from the interviewees. The Funnel approach is intended to reduce the tendency of interviewees to answer questions

in a way they believe the researcher welcomes, instead of offering their own opinions (ibid). All interviews were audiotaped, transcribed and translated from Malagasy into French. Average interviews were 60 to 90 minutes. Prior informed consent was obtained regarding audiotaping while ensuring the teachers' anonymity. It was emphasized that there were no right or wrong answers but a range of different personal opinions. A pilot interview guide was tested with the interviewer, a Malagasy anthropologist, to ensure methodological adequacy and cultural sensitivity, profiting from his experience during former surveys in the region. The interview guide addressed four major topics with multiple sub-questions (cf. Supplementary Material 5.4, p. 124 for details): (i) general situation in the village, e.g., social environment; (ii) school environment; (iii) natural environment; (iv) teacher trainings. Major topics included structural conditions of the schools such as availability of material and trainings, environmental situation and problems in the region, as well as environmental education and possibilities of its implementation. After each interview, participants completed a short questionnaire, indicating biographic information and details on their personal education and career.

To allow for triangulation of results, the semi-structured interviews were complemented by further applying a participatory problem analysis workshop, ARDI (Actors, Resources, Dynamics, Interactions; Etienne et al. 2011), focus groups, participant observations and archival research. ARDI is a methodology deployed to collectively analyze a problem. During this two-day workshop, 12 teachers (randomly selected from the 54 interviewees) addressed the problem that there is not enough material for (environmental) education, and determined involved actors, existing and needed resources, dynamics in the system, as well as interactions between its components. Additionally, 6 focus groups totaling 50 participants were conducted. The majority of the teachers were the same as for the interviews (with few replacements). These meetings followed a similar structure as the interviews, but permitted further discussion in greater detail of teaching approaches and other issues. The interviews had revealed some gaps that could be filled with the results from the workshop and meetings. Additional data to complement and verify the interviews was obtained from the group approaches.

Data analysis was supported by the commercially available software program MaxQDA 11 which uses data management techniques such as multiple levels of

coding, memo creation and code segment search. Coding is the method by which text is classified, analyzed, and grouped into categories. These were developed, tested and adapted while considering objective, research question, methodological approach and resources.

5.3 Results

5.3.1 Primary school system

The two Alaotra CISCOs (*Circonscription Scolaires*) with 43 Chef ZAP (*Zone Administrative et Pédagogique*, the administrative districts) currently oversee a total of 702 primary schools; 540 EPPs (*Ecole Primaire Publique*, public schools) and 162 EPs (*Ecole Privée*, private schools). Over 3,300 teachers are responsible for the education of nearly 116,000 pupils between 7 and 15 years old (Maminirina et al. 2006, CISCO 2013). The CISCO Ambatondrazaka teaches students from first to fifth grade while pupils under the authority of CISCO Amparafaravola are supposed to attend primary school until seventh grade (T7). However, T6 (6^{th} grade) and T7 are realized in 61 out of 343 schools only (57 public and 4 private schools) resulting in 17.8% of the schools implementing this new model of having seven grades in primary school since 2009.

There are three employment types at EPPs: i) *Fonctionnaires*: 930 (37%) of the present teachers were recruited and are paid directly by the Ministry of National Education; ii) ENFs: 969 (38%) are community recruited teachers; the *ENF subventionnés* (*ENseignant* FRAM) are paid half by the Ministry of National Education, and by the pupils' parents, respectively; iii) *ENF non-subventionnés*: 643 (25%) have to be financed by the parents alone.

The 18 sampled schools have an average class size of 49 pupils with a minimum of 18 and a maximum of 92 children per class. School sizes ranged from 5 to 23 classes with 4 to 24 teachers, respectively. Of the 54 interviewees, 74% were women and 26% men, reflecting the fact that the majority of the Alaotra EPPs' teachers are women. The retirement age for teachers is at 60 years. The sample size shows that more than half of the teachers are close to retirement (53%).

Almost all teachers have attended secondary school, but only 9% hold a university degree. Out of the 54 teachers, 65% are *Fonctionnaires*, 17% are *ENF subventionnés*, and 18% are *ENF non-subventionnés.*

The CISCO's responsibility is to implement the school program that the Ministry of National Education delivers via the DREN (*Direction Régionale de l'Education Nationale*, regional direction for education). The main objective is a continual amelioration of results, i.e., the increase of successful exams passed by the school children. The Chefs ZAP assist the CISCO in the delivery of the school curriculums' content by organizing training sessions to transmit instructions and methodological modifications to the directors and teachers of the EPPs.

According to the teachers, teaching subjects are received in irregular intervals (e.g., the CISCO organized trainings every trimester or every three months). Each month there is a *Journée Pédagogique* (one day teacher training) and once a week a *Conseil de Maître* (teacher's meeting) during which the teachers have the opportunity to exchange with their school directors and amongst peers. The Chef ZAP as instructor can be supported by the CISCO's *Equipe Pédagogique* as there are the *Adjoint Pédagogique*, the *Conseillers Pédagogique* and the Chef CISCO. The CISCO is also responsible for the follow-up and monitoring of the teachers. These *suivis* are mainly conducted by the Chefs ZAP and serve as control measures to ensure the curriculum-relevant topics have been transmitted properly during the CISCO trainings, but also to assess the teachers' ability to implement the provided subject contents in their classrooms.

5.3.2 School curriculum and teaching methods

One school year in Madagascar lasts nine months, i.e., from October to July. Generally, there is one teacher for each class, teaching all school subjects in the respective level (T1-T5/T7). A lesson takes 30 minutes while the teaching approach consists of consecutive stages which must be completed in order. The revision of the previous lesson is followed by an introduction and *préacquis*, i.e., children will recall what they know already about a certain topic. The next steps are: giving the title of the lesson, teacher presentation of the new lesson, application and group work, and finally ending with an evaluation (report and identification of results as well as rectification). To execute their lessons, several approaches are available as teachers stated in the ARDI workshop: banking education (sensu Freire 1970, Dewey 2004) where the teacher presents the content to the pupils without discussion or any other interaction; the active and participatory method that are the most efficient ones for teaching, allowing pupils for example to manipulate material during experiments; different strategies such

as group work and individual work, encouraging the pupils to play games or using little songs and rhymes to transmit the lesson's content. These methods and strategies are supplemented by approaches *(démarches*) and procedures *(procédés*) from the Ministry of National Education and NGOs. According to the teachers interviewed, the teaching methodologies are changing frequently with the mandatory application of new approaches promoted by the CISCO: APC (*Approche Par la Compétence*), APS (*Approche Par la Situation*), MITAFA (*MIara-mamolavola ny TAnana ho FAhalalàna*, doing experiments with the pupils to understand science; introduced by DEFI, a French NGO). There is a trend to move away from the banking education towards more group and participatory work which is for example encouraged in the APC context. In order to comply with the new directives despite a shortage of material, the teachers oftentimes are forced to develop teaching material on their own. However, since teachers are required to follow the school program, there is often insufficient time available for implementation of these non-traditional methods (e.g., going to the market to introduce mathematical problems in an interesting way).

The main school subjects are mathematics, Malagasy, earth and life science (SVT: *Science de la Vie et de la Terre*), geography, French, social studies (TSM which includes FFMOM/ *éducation civique* and history); complemented by music, art, sports, recitation (i.e., repeating something aloud from memory, e.g., recitation of traditional poems) and reading. The teacher's ranking of these school subjects revealed no common agreement on the practical importance of the school subjects for students later in life. There is, however, a trend showing reading to be the most important skill for adult life, followed by Malagasy, writing and mathematics; the non-school subject household is ranked on second place while environmental education figures comparatively low (Figure 5.1).

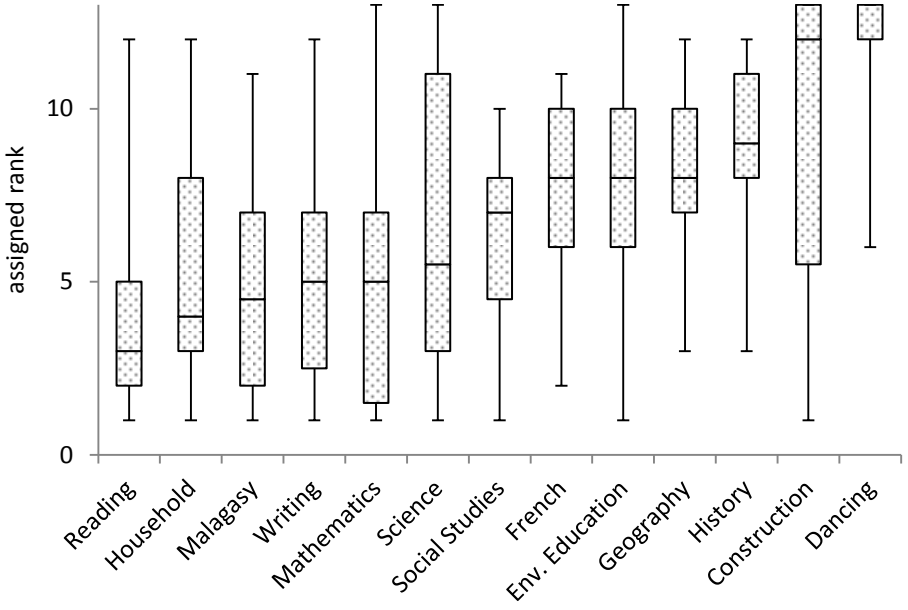


Figure 5.1 Ranking school subjects. Teachers (n=51) ranked 13 cards with school subjects (e.g., Malagasy, geography, history) and non-school subjects (e.g., housekeeping, dancing, environmental education) according to importance for after school life. The box-whisker plots show median, upper and lower quartiles, and minimum and maximum rank of the respective school subjects.

5.3.3 Teacher's understanding of environmental education

Teachers' understanding of 'education' in general was described mainly as "transmission of knowledge". Several teachers added that education is "learning on the intellectual, physical, and spiritual level" while others described it as learning how to act as a "good citizen", i.e. showing a "good behavior in society". To better understand what exactly environmental education means to the local teachers, we asked this question in the face-to-face interviews, as well as in the ARDI workshop and focus groups. During these group meetings, the following definition of environmental education has been compiled: it is the "transmission of knowledge about the environment", thus "learning about everything that belongs to the environment, about existing environmental problems and their possible solutions", and about the "protection of the environment". The teachers stated that it is important to know who the actors are (who have destructive impact on the environment) to be able to "become a responsible citizen". While teaching environmental education, knowledge on "everything that surrounds us",

"the whole that is visible and invisible" is been transmitted. According to them, both, natural environment (e.g., water, forest, including humans) and anthropogenic environment (e.g., houses, roads) are addressed.

During the one-on-one interviews, simpler definitions of environmental education were listed compared to the group meetings, mainly encompassing what the environment entails and defining environmental education as "transmission of knowledge about these components". Some teachers however also included the conservation aspect: environmental education is "teaching the pupils about the components of the environment and its importance. How can it be conserved? Who is responsible for its destruction? What are the consequences of this destruction?" Another interviewee stated that "environmental education is teaching people what the environment constitutes, its state or condition and finally its conservation".

Teachers state that environmental education is already taught in the current school system even if no specific school subject exists for this. In their opinion, best suitable for the integration of the environmental topics are the school subjects SVT (*Science de la Vie et de la Terre*), FFMOM and geography, but also Malagasy, French, history and even mathematics offer such possibility to some degree. Building on this background, teachers' opinions on the importance of environmental education compared to school and other non-school subjects varied: though environmental education ranked amongst the least important topics on average (Figure 5.1), personal opinions were quite diverse. Sixteen percent declared environmental education to be the most important topic, 12% ranked it on 2nd, 18% on 3rd and 4% on 4th and 12% on 5th rank. The remaining 40% were distributed on ranks 6 to 11. None of the interviewees ranked it the least important topic for a primary school. In terms of a possible implementation of environmental education, 100% of the interviewees said that it already is included in the current curriculum, i.e., environmental education appears in many of the topics they are teaching while several book chapters are dealing with the environment. Geography deals with environmental destruction by addressing bush fires and *tavy* (slash and burn agriculture). *FFMOM* (*Fanabeazana sy Famolavolana Maha-Olomendrika*, i.e., education with the aim to make the children become an adult person with good manners) also deals with 'the environment' where they introduce environmental education by addressing "all questions concerning the health as for example personal hygiene". When they

present possible consequences of using river water, “the environment is already introduced”. This example suggests that some teachers believe environmental education is sufficiently taught as soon as the natural or social environment is barely mentioned. Teachers stated that other book chapters are explaining ‘What is the environment?’ or treat the topic ‘How to avoid erosion’ or ‘The protection of the environment’, herein focusing on the protection of plants and animals.

The teachers were aware of many kinds of environmental problems in and around their villages, that can be grouped into the three categories ‘ecosystem’, ‘humans’, and ‘agriculture’ (Figure 5.2). The ecosystem perspective entails destructive human practices and their consequences on the natural environment. The social or human perspective mainly focusses on problems in the village that are related to the low development state, and the agricultural perspective comprises causes of management strategies and climate conditions that have negative impacts on the agricultural output. When describing problems of the natural environment, the teachers oftentimes just briefly mentioned the environmental issue and then focused on the social impact resulting from it.

When answering the question about regional environmental problems, one third of the interviewees mentioned poverty as a cause for environmental destruction and one fifth tried to explain people’s behavior with their mentality or mindset, in particular referring to people’s laziness and jealousy: “They know that they shouldn’t burn the marshland, but when they see the advantages and benefits of the persons who protect the environment here, they ask themselves why this benefit is not shared but reserved to and kept by one person. So they quarrel and in periods like now [political instable times with no working executive powers / dry season] they continue to burn the marshland”. Speaking about mentality, one third of respondents complained that people do not plant trees or do reforestation but also address the problem that “someone burns them [the planted trees] all the time”. Teachers declared fire to be the most threatening problem for an intact environment when showing them ten different photographs with potential environmental problems being present at the lake to date. These photos were chosen according to what had been encountered during the first few weeks on the ground, either by sight or by reports from residents. Almost all interviewees also identified charcoal and erosion to be important environmental pressures (98 and 96%, respectively), as well as crayfish (92%). Inundation was judged a potential environmental problem by 77% of the interviewees, while the

invasive fish species snakehead and pesticides were identified by 58% and 40%, respectively. Only 25% declared (marsh-penetrating) zebu to be potentially problematic; 6% listed the invasive plant water hyacinth; rice fields were not listed by any of the teachers (cf. Supplementary Material 5.1, p. 121).

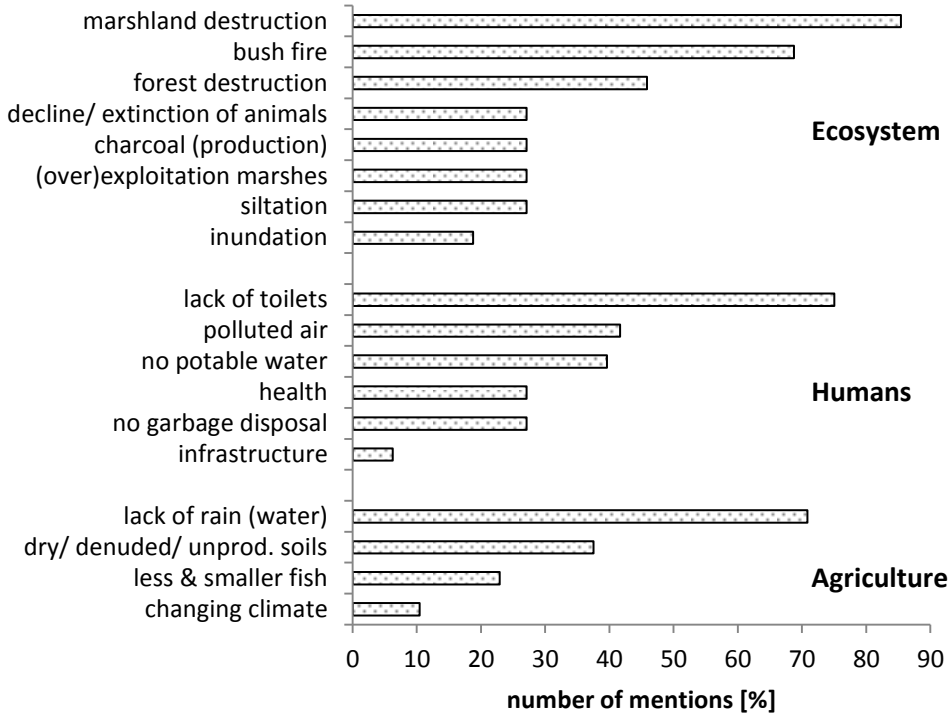


Figure 5.2 Listing regional environmental problems. The teachers specified environmental problems as perceived by them ("Please describe the environmental situation in your community. Are there environmental problems? Which environmental problems do exist?"). The various answers were grouped into the three main categories 'ecosystem', 'humans', and 'agriculture' (problems that affect directly the agricultural production) with the above listed sub-categories. X-axis shows the percentage of interviewees (n=48) who mentioned the respective issue listed on y-axis.

5.4 Discussion

5.4.1 Language barrier

Since many of the Alaotra teachers are not confident with French or speak too little to allow extensive discussions, all data sampling had to be done in Malagasy. Interestingly, many of these teachers are from the generation of the *malgachisation* and hence did not have the opportunity to learn French. To reduce the risk of missing out on details, i.e., getting lost in translation, different approaches for data sampling were used allowing for triangulation of the results. Additionally, random translations have been cross-checked by the interviewer to ensure quality. Though even with a seemingly small data set (n= 54 out of over 3,300 teachers of public primary schools) we can be confident that the data set is representative, since there were many agreements in terms of responses.

Another language barrier is present in the school system itself. Today, Malagasy primary school classes are bilingual (Malagasy and French). In the first two grades, pupils are taught in Malagasy, the third grade allows theoretically a bilingual transition to 4th and 5th grade where lessons are or at least should, according to the curriculum, be held in French. The question remains, however, to what extent this is or can be realized by the teachers that were educated during the *malgachisation*. Various publications declare the teaching language a key factor for learning (Brock-Utne 2000, Heugh 2000, Benson 2004, Abadzi 2006) and state the importance to teach in the mother tongue. Language as "basic tool for thought, communication, reasoning, and making sense of a rapidly changing world" (Arnold 2004: 3) can even serve for predicting later abilities and school success (Hart & Risley 1995, Shonkoff & Phillips 2000). In Madagascar, however, exams are held in French from the third grade on which poses a great language barrier to learning and succeeding at school.

5.4.2 Lack of trained teachers

In the Alaotra region, the primary public schools are facing an uncertain near future due to an increasing lack of professionally trained teachers. A significant body of aging teaching staff is currently close to retirement and teachers are complaining that since 2009 there is no more recruitment of teachers paid by the state (*fonctionnaires*) and thus more ENFs (community-recruited teachers) are hired for less payment. *Fonctionnaires* normally obtain trainings for two years at

the École Normale before they are recruited by the Ministry of National Education, whereas the ENFs are selected via application by the CISCO without necessarily having such a considerable education. This could potentially contribute to a deterioration of teachers' educational levels in the region. Our data sample includes 65% *fonctionnaires* opposed to 37% in reality. This might result in a slightly different picture regarding teacher's educational levels as well as knowledge and understanding on certain topics. If few well-trained teachers are recruited, this inevitably will leave a void and the overall educational quality level in the first grades will decrease. It is well-known, however that quality teaching is especially crucial in the first grades (Bruns et al. 2003, Abadzi 2006) and that attitude and behavior are mainly developed based on experiences in childhood (Kidd & Kidd 1989, McDuff & Jacobson 2000, Jacobson et al. 2006). Sobel (1997) admonishes not to impose ecological problems on children before a certain age to avoid the feelings of fear and disempowerment ('ecophobia'). He suggests age-appropriate environmental education contents for developing the necessary emotional connectedness that will later allow them to deal with the complex ecological issues. Such age-appropriate education, however, requires accordingly trained teachers.

Ongoing political changes and irregular trainings pose on the one hand insecurity and require (methodological) adaptation by the teachers, but also give them the impression that their "expertise is questioned". On the other hand, the principle *formation de formateur* (cascade training: the Chefs ZAP train directors and teachers on the ground after having received trainings themselves) can offer an effective approach for introducing new methods and the changing requests by the Ministry of National Education keep the educators flexible and open for new teaching approaches. Since 2012 (start of the AMBio research project, Alaotra Marshland Biodiversity), the Chef CISCO in Amparafaravola and lately the Chef DREN in Ambatondrazaka have been replaced, and further changes are likely to follow. Such instability might be one reason amongst others why plans by the government to restructure and improve the school system, and to include Malagasy biodiversity into teaching, have been on hold (Dolins et al. 2010). Even if the Malagasy curriculum addresses some environmental topics (cf. Ormsby 2008) there is a lack of site-specific content.

In the past decades, NGOs have been filling these gaps by providing educational material and proposing new teaching approaches (e.g., Waeber 2006, Maminirina et al. 2006, Dolins et al. 2010). However, the provision of material alone might not be sufficient when teachers do not know how to use the material (cf. Dolins et al. 2010) or if they lack understanding of the topic or the motivation to teach it. Developing locally adapted tools and training teachers in how to use them might increase the chance of meaningful use of such educational material in the classroom. The integration of new material should be endorsed by the CISCOs, an approach generally taken by promoters of environmental education in Madagascar (e.g., Masoala curriculum development, Ormsby 2008; MFG's Saturday School at Park Ivoloina, Nirina L. Rakotomalala, pers. comm., MWC's educational posters and comic books). Teachers in the Alaotra region state that they are regularly using the material provided by MWC. Research by this NGO and ENS (École Normale Supérieure) has shown that the material can be integrated in school subjects such as mathematics, Malagasy, French, geography and SVT (Rafidimanana Rajosera 2013).

5.4.3 A matter of perspective

Many of the NGOs acting in Madagascar are from foreign, mostly western countries and confront their values and perspectives with the ones of the Malagasy communities. Concerns about biodiversity loss and threatened lemur species are motivating various NGOs to be active and to bring in environmental education to promote conservation. This situation can possibly cause a 'clash of values'. On the one side are the NGOs with an implicit view on education and the emphasis on environmental education, on the other side the regional traditional value systems with locally meaningful and long-time corroborated perspectives.

A value, as defined by Tilbury (1995: 201) is "a certain belief, attitude or conviction that is consistently reflected in one's behavior. Values determine decisions and actions and are thus of great consequence to environmental education". Breidlid (2009) addresses the drawback of such western-based educational systems in Africa. He criticizes the exclusion of alternative, i.e., African knowledge and value systems from the curricula of the post-colonialized countries. He further states that ignoring traditional values and leaving out the spiritual sphere (traditional beliefs, ancestors) could cause a collapse of the social and moral world and existing solidarity amongst the population might get lost.

Interestingly, in the Alaotra region none of the interviewed teachers did refer, for example, to ancestors as part of the environment despite their important role in tradition and beliefs of the Malagasy population (cf. Jarosz 1994, Keller 2009, Evers & Seagle 2012). A plausible reason for this could be that the current school curriculum is still based on the colonial French school system with many subjects addressing little or no Malagasy context. This assumption is illustrated by the following example. Many teachers mentioned 'polluted air' as environmental problem. French textbooks that are still in use (pers. observ.) are dealing for example with the negative impacts of factories on air quality and consequences for human health. There is no such air pollution in the Alaotra region, but teachers adopt this textbook content on their regional reality: "the environment is also affected because there are no toilets; people defecate everywhere and the air is thus polluted". Polluted air is also oftentimes mentioned in the context of waste dispersal and the lack of garbage disposals.

When the teachers ranked the different 'environmental problems' during the interviews, a congruency of western and regional perceptions appeared, for example regarding fire and charcoal of being main threats in the region. On the other hand, there was often hesitation or confusion whether, for example, the invasive fish species *Channa maculata* is representing an environmental problem (as assumed by a western perspective because it feeds on endemic fish and bird species (Andrianandrasana et al. 2005) or not. This species was chosen as representative for introduced fish species at Lake Alaotra (cf. Pidgeon 1996) that are still common today and consumed regularly. Many teachers mentioned that the *fibata* (vernacular name for *C. maculata*) eats little fish or even stated that it is the enemy of the fish stock in general. But in an environment where malnutrition and lack of protein are wide-spread, some teachers still decided not to put *C. maculata* as environmental problem despite knowing its ecological impacts. This fish thus represents a good example for a trade-off situation between negative environmental impacts versus an improved social situation. The question arises how committed and supportive the teachers can or will practice environmental education if their own '*Lebenswelt*' (this translates as 'human-life world', cf. De Laguna 1960) is not reflected in the teaching material and content? Local realities need to be taken into account to increase probability of acceptance and success of environmental education programs.

Following the UN, teachers are seen as crucial in delivering the sustainability message. At first glance, the teachers' understanding on environmental education seems to be congruent with the international definitions (cf. UNESCO 1976). The teachers define it as the "transmission of all knowledge that is related to the environment (…)" with examples for environment such as forests, the air, stones, roads, and houses. In contrast, the UN concept of environmental education incorporates much more than the local perspective which represents only the first step, the knowledge transfer, of the international definition. Though knowledge is crucial in achieving higher cognitive levels such as understanding, awareness and sensitivity, attitudes and motivation, and skills for participation and action, pure knowledge transfer is clearly not sufficient as teaching objective.

According to the teachers, environmental education already appears in many of the topics they are currently teaching, and several text book chapters are dealing with the environment. However, as some of the following examples show there is a disparity of what the authors understand of environmental education and what the teachers think in this regard. For example, one teacher stated that she included environmental education by giving an arithmetic problem where the children had to calculate the benefit of 20 planted shoots of manioc. Another teacher claimed teaching about health centers to be environmental education, while another stated that knowing the benefits of trees on the hill slopes around Lake Alaotra constitutes environmental education.

During the interviews, when the Alaotra teachers listed environmental problems, the focus revolved mainly around social and health related topics ('humans'). The teachers revealed detailed descriptions and understanding of problems when they talked about social and economic misfits using oftentimes compelling examples. Fewer details were touched on when talking about the natural environment, by barely naming a problem or briefly listing a sequence of several ecosystem-related issues, to end in many cases again with a social-centric environmental problem: "the bush fire causes soil loss and hence the canals here get clogged by the accumulation of mud which are brought by the waters and the streets get flooded" and "even the well (…) is not very sanitary because it is not covered and when the rain is arriving, the drain water pours into the well, together with the waste from the surroundings". This emphasis on social impacts, even when ostensibly speaking about natural environments, matters locally and needs to be addressed when drafting environmental education programs. During

some of the interviews, the impression occurred that the teachers were citing facts without deeper understanding of interrelationships or reasons. Many of the Alaotra teachers are from the generation of the *malgachisation* and have been indoctrinated with recitation teaching by the socialist regime. This causes unpredictable consequences for the next generations as (some of) these educators did not learn how to think critically but to learn by heart and to repeat slogans only.

As long as the Alaotra population suffers from deficient hygiene and health issues there will be little sympathy for ecosystem problems, and relationships between deteriorating ecosystem services and health or development might remain misunderstood. A central question remains how the different value systems of external western providers of environmental education (such as NGOs, cf. Rendigs et al. 2015) and local teaching staff and communities can be married to achieve development in all environmental aspects in combination with conservation success. This is where environmental education can act as leverage, emphasizing the linkages between a healthy environment and its services, but also by serving the local needs by introducing for example concepts such as PHE (People, Health, and Environment; cf. Robson & Rakotozafy 2015 for a successful model in Madagascar).

5.4.4 From teacher-centered learning to learner-centered approach

As Kollmuss & Agyeman (2002) stated there is no apparent, direct correlation between knowledge and pro-environmental behavior. Having in mind that action competence may be the one main goal of environmental education, Jensen (2002) adds that a clear distinction should be drawn between behavioral change and action. Behavioral change is oftentimes directed by others, while action "should be directed at solving a problem and it should be decided upon by those preparing to carry out the action" (Jensen 2002: 326), direct or indirect, individually or collectively.

How these obvious gaps between environmental knowledge and attitude change towards positive environmental actions may be bridged is still open to debate. It is well known that knowledge about and positive attitudes towards the environment are necessary prerequisites but in themselves are not strong enough to lead to action (Heberlein 2012, Schultz 2011). An environmental education program aimed at changing people's behavior should therefore steer away from teacher-

centered learning (banking education). It needs a learner-centered approach that is connected to the scholar's every-day life and has a real issues orientation, and is in its nature participatory and allows the learning process to be driven by the learners. It should integrate new teaching methods like outdoor activities, participative inquiry, group activities and discussions or action learning on real-life problems. This approach targets a broad set of scholars' competencies, thereby facilitating systemic and critical thinking, reflection and future orientated thinking. This strengthens the competencies of learners for shaping their future in a positive way (consider Cotton & Winter 2010, de Haan 2010, Tilbury 2007, Palmer 2002 for an in-depth discussion on appropriate teaching methods). Furthermore, a culture-specific approach to environmental education taking into account local values and belief systems is also needed to address and ensures environmental behavior via education (Boeve-de Pauw & van Petegem 2013).

The concept of the *Gestaltungskompetenz* (cf. de Haan 2006, and references therein) promotes a learning to invoke change (in for example ecological, economic or social behavior) through a combination of skills acquisition and competencies (i.e., to build on children's every-day experiences) that goes beyond the pure accumulation of 'inert-knowledge' (sensu Renkl et al. 1996). Such knowledge-based or banking education is one of the main challenges in Madagascar's school system. Not surprisingly, teachers judge the school subjects reading, Malagasy, writing, and mathematics as likely most important to be successful in after school life, being congruent with the set of principles the Ministry of National Education stated for their school children. When leaving the primary schools in Madagascar they are expected to master (i) academic achievements such as skills in reading and writing, arithmetic, and problem solving (e.g., Bloom's taxonomy: comprehension, application, analysis, synthesis and evaluation), (ii) social skills (attitudinal modernity, interpersonal effectiveness, community involvement), and (iii) economic success (earnings and productivity; Heneveld & Craig 1996). The non-school subject household being ranked on second place by the Alaotra teachers correspondingly represents the social perspective.

The social environment is in teachers' perceptions higher prioritized than the natural environment. Teachers are exposed on a daily base to the consequences of the urban environment and the social problems and issues that are reflected and carried by the children into the class rooms. For example, many children are

coming from poor households, are malnourished and have low levels of hygiene. It has been shown that socioeconomic status globally plays a crucial role in children's development (Brooks-Gunn & Duncan 1997, Bradley & Corwyn 2002), and that such low status negatively affects behavioral and cognitive development in children (Grantham-McGregor et al. 2007). This results in poor performance which is reflected in the higher numbers of repeaters, or an increase in the drop-out rate (Arnold et al. 2007). Apart from this, it is well known that the experiences in early childhood shape the later learning processes; physical, cognitive, and emotional development of children are best supported by (various and rich) natural settings, i.e., children have to experience nature themselves to achieve a holistic learning (cf. Rivkin 1995). Following a more proactive and interactive school approach by visiting, for example, the market or the marshes could already act as a stimulant in this direction. Although being envisioned by the school authorities, the realization of the approach remains a challenge due to lack of resources, time and motivation.

Even if the structure of the school system provides opportunities to address environmental education or education for sustainable development, environmental education as defined by the United Nations (UN) is to date implemented in the Alaotra region only on a basic level. Potential drivers and barriers of such implementation remain to be identified. Further research in the next two years thus will focus on barriers that are opposed to the implementation of environmental education into the school curriculum and drivers that will facilitate such implementation in the Alaotra region. Addressing the questions on what potential drivers represent, and how they could be used to tackle potential barriers, can then inform the development of teaching and learning material that are adapted to the regional circumstances and learning environment. Including sustainability issues into the curriculum can be a challenge and should aim for addressing locally relevant terms and appropriate solutions rather than frightening the audience (children as teachers alike) with global problems, which are not understandable, likely irrelevant, let alone solvable on local scale and conditions (Tilbury et al. 2002).

5.5 Conclusions

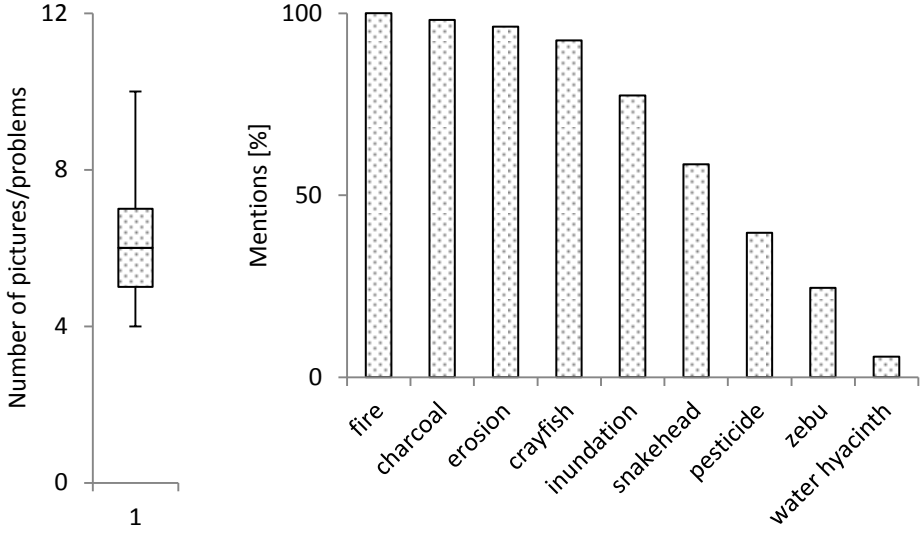
The school system in Madagascar has a hierarchic structure, and changes are commonly dictated from the Ministry of National Education or DREN and CISCO. It is thus crucial to involve the higher levels of the school system when introducing environmental education, not only the schools themselves. The DREN and CISCOs are the official government entities for the realization of teacher trainings, and are crucial partners in the delivery and implementation of such new tools.

As the primary schools are the sole formal education for a majority of rural children, teachers could act as promoter of education that will allow pupil's to face their future by furthering critical thinking. Teachers are shouldered with this responsibility. It is therefore important to overcome the banking education and to proceed towards a more participative and interactive learning, with teachers needing to be trained by the respective school authorities accordingly. Overcoming the impacts of *malgachisation* however, might still require some time and effort. The regional educators cannot be used only as instruments for implementation, but must be involved during the creation and development of educational tools or programs. It is assumed that this will increase teachers' creativity, motivation and initiative in their teaching process. Including teachers in the tool development process will provide them with new techniques, new approaches, and especially increase confidence to address new topics or to try out new ways themselves.

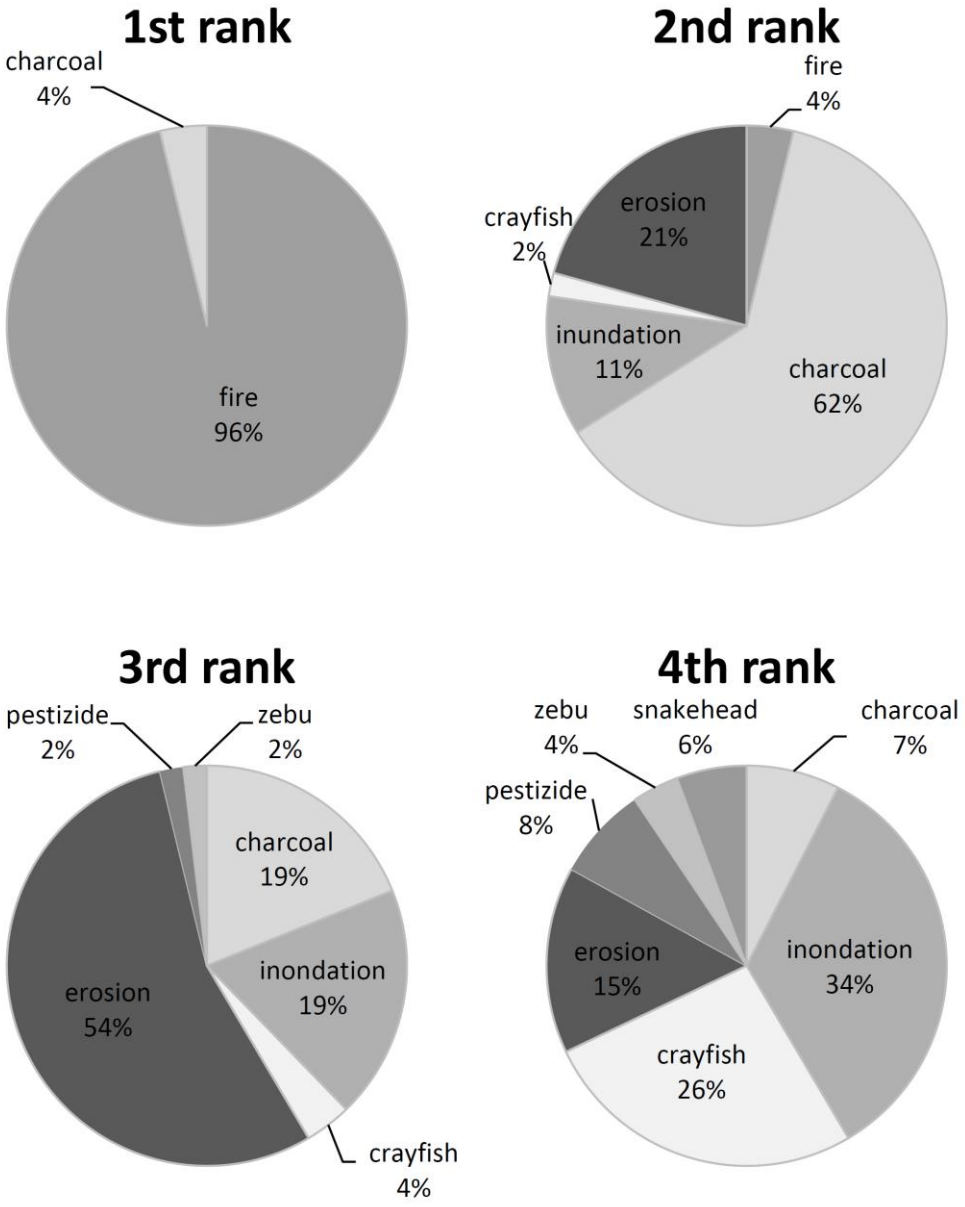
When drafting environmental education programs, the population's needs, concerns, and local value systems need to be taken into account. Consequently, a participatory approach needs to be chosen when drafting such programs. Given the anthropogenic view and emphasis on social values revealed by the interviews, the Alaotra schools and teachers might be better served with education for sustainable development rather than environmental education only. Following the principles of mutual respect, empathy and understanding will result in educational and development programs which can meet the expectations of all involved parties and are more likely to be continued even if projects or other external input such as funding are coming to an end.

5.6 Supplementary Material

Supplementary Material 5.1 Ranking environmental problems. Out of ten pictures, the interviewees were asked to choose and rank the ones that display potential environmental problems. The pictures showed fire, charcoal, erosion gullies ('lavaka') inundation, use of pesticides, marsh-penetrating zebu, crayfish, snakehead, rice fields, and water hyacinth.



Supplementary Material 5.2 The box-whisker plot shows median, upper and lower quartiles, and minimum and maximum number of identified problems (left). Almost all interviewees declared fire, charcoal, erosion and crayfish to be potentially problematic for the environment, whereas zebu and water hyacinth were not judged to represent a potential problem by most of the participants (right). Ranking based on Supplementary Material 5.1.



Supplementary Material 5.3 Distribution of potential environmental problems on ranks one to four. Fire has not only been the only problem that has been identified by all interviewees, but was also declared to be the most important environmental issue. Fire is followed by charcoal, erosion, and inundation. Ranking based on Supplementary Material 5.1.

Supplementary Material 5.4 Interview guide for the structured in-depth interviews (in French):

Interview guide for the structured in-depth interviews (in French). The standardized interview guide is organized according to the Funnel approach to avoid a social desirability bias, i.e. the interview starts with broader subjects, and then narrows down to more precise topics of interest. This interview guide consists of questions on the general situation in the village, school environment, natural environment, and teacher trainings. Following each interview, a short questionnaire (also listed below) was used to gather biographic information and details on interviewee´s personal education and career.

I. Contexte 1

1. Comment décrivez-vous la situation dans votre village? (La vie quotidienne)
2. Est-ce qu´il y a des problèmes dans votre communauté? S´il vous plait, mettez une liste suivant l´importance (5 au minimum)?
3. Et dans votre école, comment est la situation ici; c´est bien d´être enseignant/ directeur ici?

II. Contexte 2

4. Pourquoi êtes-vous devenu(e) enseignant, quelles sont les raisons?
5. Quelles sont les critères pour devenir directeur *(seulement pour les directeurs*)?
6. Quels sont vos buts comme enseignant/ directeur ?
7. Comment enseignez-vous? Quelles sont les méthodes et les matériels que vous utilisez?
8. Qu´est-ce qu´est un bon enseignant d´après vous?
9. D´après votre opinion, quelles sont les matières et les sujets importantes pour préparer les élèves à la vie après l´école?
10. Pourquoi pensez-vous que la programme de l´école doit suffire aux enfants ou pas pour affronter la vie après l´école? Est-ce qu´il est encore à jour ? Expliquez.
11. De qui viennent les idées et les directives pour vos leçons ?
12. Avez-vous l´opportunité de décider ou de choisir la façon, et les méthodes d´enseignement vous-même? Donnez au moins 3 exemples pour les méthodes/façons. Si non, de qui viennent les prescriptions?
13. A quel dégrée prescrivez-vous vos enseignants comment enseigner/ quoi faire dans les leçons? Donnez des exemples et différencier qu´est-ce qu´est déjà prescrit de la CISCO *(seulement pour les directeurs*).
14. Quels sont les buts de la CISCO ?
15. Participez-vous à des formations des enseignants? A quel fréquence et quand a été la dernière fois? Organisateur (NGO, CISCO)?
16. Quelle formation vous a plu le mieux et pourquoi?

17. Comment présenter-vous les contenus des formations aux collèges/enseignants qui n´ont pas participés aux formations? (la manière, façon & détail)
18. Comme directeur, est-ce que vous encourager vos enseignants de participer à des formations ? D´après vous, à combien des formations un enseignant devrait participer par an/ depuis son carrière ? Est-ce qu´il y a des formations obligatoires ? Combien, quel sujet et de qui *(seulement pour les directeurs*)?
19. Qu´est-ce que les enfants aiment le plus dans votre classe, c´est à dire quand est-ce que vous pensez qu´ils sont plus attentifs et participatifs ?
20. Si vous souhaiteriez quelque chose pour votre école, ce sera quoi?

III. Contexte 3

21. On a déjà parlé de la situation communauté en général… S´il vous plait, décrivez la situation environnementale (la nature) dans votre communauté?
22. Est-ce qu´il y a des problèmes de l´environnement ? Quelles sont les problèmes de l´environnement? Faites une liste suivant l´importance (5 au minimum).
23. Est-ce que vous en discutez avec les collègues, la famille, les amis, …?
24. Comment décrivez-vous la condition des marais près de votre communauté? *Après la réponse:* S´il vous plait, choisissez entre 1 et 6 : très bien, bien, plutôt bien, plutôt mal, mal, très mal.
25. Quelles sont les importances des marais? S´il vous plait, faites une liste suivant l´importance? *Après la réponse:* plus de 5; utilities mais aussi fonctions.
26. Voyez ces photos: d´après vous, quelles pourraient être les problèmes de l´environnement ? Identifiez en 2 ou 3 mots les photos et regroupez-les respectivement.
27. Connaissez-vous (le nom de) cet animal? *Si oui :* Où est-ce qu´on trouve le Bandro? Qu´est-ce que vous savez encore sur cet animal ? Ou est-ce que vous avez appris ça? *Si non:* c´est le Bandro, est-ce que vous avez entendu parler de ça avant?
28. Donc, en tant qu´enseignant, utilisez-vous parfois des photos pendant votre leçon? Si oui, donnez des exemples; si non, expliquer pourquoi pas?
29. Comme directeur, est-ce que vous encourager et soutenez vos enseignants d´utiliser des matériels différents pendant les leçons, comme par exemple des photos *(seulement pour les directeurs*)?
30. *Montrer les cartes des matières : français, malagasy, mathématiques,...* S´il vous plait, classez les sujets suivant l´importance.

IV. Contexte 4

31. *Montrer la carte 'éducation environnementale'* (EE) : Vous pensez que c´est/ ce n´est pas important, donc… Qu´est-ce que c'est, l´EE, donnez la définition?
32. S´il vous plait, donnez des raisons pourquoi l´EE est important ou non.

33. D´après vous, est-ce que c´est possible d´enseigner l´EE dans le système scolaire actuel? (Est-ce qu´il y a de temps/des moyens pour ça? A quel dégrée?)
34. Dans quelle matière peut-on intégrer l´EE et comment? (Expliquez et proposez une méthode/ idée.)
35. A part l´école, est-ce qu´il y a des endroits éducatifs? (comme zoo, musée, spectacle)
36. A part l´école, est-ce qu´il y a des endroits éducatifs pour l´EE?
37. Pensez-vous qu´un jour ou un après-midi pour explorer et découvrir la nature pourrait être un succès? Comment pourrait-on réaliser ça?
38. Avez-vous déjà participez à une formation concernant EE?
    - *Si oui* → De qui (organisateur) et quand ? *Si avec MWC : on continue avec la formation de MWC ; si autres: on continue avec la meilleure formation*
    - *Si non:* Avez-vous participez aux autres formations? De qui et quand? Choisissez la meilleure formation ; *on continue avec la meilleure formation.*
39. Qu´est-ce que vous avez fait/appris pendant la formation? De quoi vous vous souvenez?
40. Donnez des exemples, quelles choses, que vous n´avez pas su avant avez-vous appris?
41. Donnez les côtés positifs et négatifs des formations. En tout cas, est-ce que ça vous a plu?
42. Que suggériez-vous s´il y aura une prochaine formation ?
43. Utilisez-vous encore des matériels des formations et enseignez-vous encore les contenus vous avez appris?

Si non: pourquoi pas (pas du temps, matériels, motivation,…)

Si oui: Fréquence? S´il vous plait, décrivez la dernière situation quand vous avait enseigné le contenu de la formation (quand, quelle classe, matériels utilisées, dans quelle matière, thématique)

44. Avez-vous discuté ou parlé avec vos collègues sur la formation? Qu'est-ce que vous avez raconté et en quel détail?
45. Est-ce que le directeur vous donne appréciation/ vous donnez appréciation ou soutien si vous/ vos enseignants intégrez des nouveaux contenus dans vos/ leurs leçons? Comment?
46. Est-ce que la CISCO vous donne appréciation ou soutien si vous intégrez des nouveaux contenus dans votre école? Comment *(seulement pour les directeurs*) ?
47. Qu´est-ce que les élèves aiment/ n´aiment pas concernant les matériels *(pour MWC-enseignants = la BD & le poster)?*
48. Donnez une explication pourquoi vous-mêmes aimez ou aimez pas les matériels? *(pour MWC-enseignants = la BD & le poster)*? Que voudriez-vous changer si vous étiez le concepteur?

Petit questionnaire pour les enseignants/ directeurs

49. L´âge ……
50. Sexe ……
51. Domicile (Nom de village) ……
52. A quelle distance du bord du Lac Alaotra habitez-vous? ……
    ☐ Moins d´une heure ☐ 1 -3 heures ☐ Plus de trois heures
53. Groupe ethnique ……
54. Type d´emploi ☐ permanent ☐ contractuel
55. Qui paye votre salaire? ……
56. Quelle est la nature de votre salaire? ☐ En espèce ☐ En nature
57. Est-ce que vous pensez que votre salaire est adéquat à votre position et expérience?
    ☐ Très bien ☐ bien ☐ plutôt bien ☐ plutôt mal ☐ mal ☐ très mal
58. Durée de l´emploi ……
59. Depuis quand êtes-vous enseignant? ……
60. Depuis quand travaillez-vous à cette école ? ……
61. Depuis quand êtes-vous directeur/directrice? ……
62. Comment êtes-vous devenu(e) directeur/directrice ?
63. Combien des enseignants travaillent à votre école (à part vous)?
64. Les quels de ces établissements avez-vous fréquenté pendant votre année d´étude?
    ☐ EPP ☐ CEG ☐ Lycée ☐ Université
65. D´où est-ce que vous recevez votre sujets d´enseignement?
66. Et à quelle fréquence?
    ☐ Par jour ☐ 2x/semaine ☐ 1x/semaine ☐ par mois ☐ par demi an
67. Avez-vous déjà participé à des formations spécifiques de l´enseignement avant l´emploi actuel? Quelle sorte de formation, spécifiez s´il vous plait.
68. Pendant votre emploi actuel, participez-vous encore à des formations? Fréquence et type de formation?
69. Si vous avez participé à une des formations de MWC: c´était quand? Dans quelle année?
70. Combien des fois partez-vous à Ambatondrazaka/Amparafaravola/Tanambe ou Antananarivo par an, respectivement?
71. Si vous ne travaillez pas, par quoi vous êtes intéressé en général et quel sont vos distractions?

Supplementary Material 5.5. Acronym table.

	Acronym	Meaning
Organisation school system	CISCO	*Circonscription Scolaire*; regional government school authorities, responsible for amelioration of results and delivery of the school curriculum.
	DREN	*Direction Régionale de l'Education Nationale*; Regional direction for education that governs several CISCOs, i.e. representing the link between ministry and CISCOs.
	ENF	*Enseignants FRAM*; community recruited teachers that are paid by the FRAM. *ENF subventionnées* obtain additional salary by the ministry in contrast to *ENF non-subventionnées*.
	EP	*Ecole privée*; Primary private schools
	EPP	*Ecole primaire public*; Primary public schools
	FRAM	In Malagasy *Fikambanan'ny Ray Amandrenin'ny Mpantra*. Association of pupils' parents; the FRAM pay e.g. (part of) the salaries of the ENF, but also necessary school material and reparations.
	T1 to T7	First to seventh grade (in Malagasy T= *taona*; year)
	ZAP	*Zone administrative et pédagogique*; local administrative districts. The Chefs ZAP are the links between CISCO and schools and in charge of teacher trainings.
School subjects /methodology	SVT	*Science de la Vie et de la Terre*. School subject 'Earth and life science'.
	FFMOM	In Malagasy *Fanabeazana sy Famolavolana Maha-Olomendrika*; *Education civique*; School subject 'Social studies'
	APS	*Approche par la situation*; teaching approach
	APC	*Approche par la compétence* ; teaching approach
International context	GDP	Gross Domestic Product
	HDI	Human Development Index
	UNCED	United Nations Conference on Environment and Development (Rio de Janeiro, 1992)
	UNDP	United Nations Development Programme
	UNEP	United Nations Environment Programme
	UNESCO	United Nations Educational, Scientific and Cultural Organization
	WCED	World Commission on Environment and Development
Other	ARDI	Participative problem analysis approach during which all actors, resources, dynamics, and interactions linked with a defined problem are identified.
	ENS	*Ecole Normale Supérieure*. Teacher training school in Antananarivo
	INSTAT	*Institut National de la Statistique*; governemtal entity for production and collection of official information and statistics on Madagascar
	MWC	NGO 'Madagascar Wildlife Conservation'
	NGO	Non-governmental organization

Chapter 6

Teachers' knowledge, attitudes and skills, and professionalization of EE

Abstract. Environmental education is internationally recognized as a key factor for sustainable development. In Madagascar, EE programs are largely implemented by NGOs being informed by the UNESCO framework. This study aims to assess its usefulness to guide EE research on the ground, and to explore whether theoretical advancements can inform and professionalize EE in Madagascar. Fifty-four in-depth interviews were conducted with teachers of 18 primary schools at Lake Alaotra. The UNESCO framework provided useful guidance to obtain a broad understanding about teacher's awareness, knowledge, attitudes, and skills regarding the environment and EE. However, theoretical advancements that foster holistic teaching show promise in reducing the divide between research and practice and in achieving tangible benefits both for the environment and the population on the ground.

Preprint: **LM Reibelt**, T Richter, PO Waeber & J Mantilla-Contreras. Holistic environmental education in primary schools in Madagascar – fiction or feasible?

6.1 Introduction

Over the past 40 years, UNESCO has published various reports and policy guidelines on environmental education (EE), well-known among practitioners and researchers alike. Central to the global policy frameworks are the objectives of EE, namely to develop the *awareness* and *knowledge* of the environment and related problems, positive *attitudes* towards the environment and its conservation, and *skills* to be able to theoretically judge and practically solve environmental issues (e.g., UNESCO 1976, UNESCO 1978). These attributes may empower people to contribute to environmental protection and sustainable development (ibid). Despite the dated nature of the reports as well as advances in psychology, pedagogy, and education science including the development of various concepts and models to identify factors shaping environmental attitudes and behavior, the frameworks are still valid today and many non-governmental organizations (NGOs) from international to grassroots levels continue to use the UNESCO framework to guide their EE interventions. These attributes are still promoted today (e.g., UNESCO 2013) and thus still drive educational objectives of practitioners globally by defining what is needed and what should be promoted for a development towards sustainable living.

In the 1970s and 1980s, environmental educators were faced with conceptual and theoretical challenges regarding the question of how to achieve these global educational goals. Twenty years later, scholars in the EE field argued that, in order to holistically promote the UNESCO goals in learners, environmental education needed to include the three dimensions of education *about*, *in*, and *for* the environment (e.g., Fien 1993, Tilbury 1995, Palmer 1998). The three-dimensional model contains at its core the attributes which are required for an informed, responsible, and active world population: awareness, knowledge, understanding, attitudes, values, and skills among people. According to the theoretical framework, EE as education *about* the environment addresses awareness, knowledge, and understanding about the environment, and has been described as a 'head approach' (Tilbury 1995). Education *in* or *through* the environment addresses the 'heart' component through contact with nature. This pupil-centered and activity-based approach is meant to develop awareness and concern regarding the environmental situation. The third component of the framework, education *for* the environment, focusses on actual preservation and improvement of the environment, i.e., active participation and respective skills in the resolution

relevant in helping individuals become environmentally literate citizens (cf. Marcinkowski 1991, Orr 1992, Stables & Bishop 2001, Cutter-Mackenzie & Smith 2003). The fundamental assumption for both scientific and applied contexts was initially that people who have the knowledge and understanding of the environment will also take actions to prevent environmental destruction or will address environmental problems in their surroundings, and thus automatically contribute to sustainable development (Gough 2013, Palmer 1998). Research evidence, however, indicates that knowledge and positive attitudes towards the environment alone do not prompt pro-environmental behavior (Hines et al. 1987, Hungerford & Volk 1990, Jensen 2002, Kollmuss & Agyeman 2002). Despite the evidence, practitioners continue to use the UNESCO guidelines, risking an increasing divide between practitioners and theoretical advancements in the EE field.

The majority of EE interventions in Madagascar are realized by NGOs, as it is not a compulsory element in the Malagasy school curriculum despite international recognition of EE as a key factor in sustainable development (*Madagascar* is the name of the country, whereas *Malagasy* refers to someone or something from Madagascar, including the people and the language). EE in Madagascar's primary school system is still rudimentary (Reibelt et al. 2014) when compared to EE programs in other countries (e.g., Ballantyne et al. 2001, Ballantyne et al. 2005, Farmer et al. 2007, Woodhouse & Knapp 2000). The common assumption of organizations which offer EE programs is that improved conservation outcomes can be reached through educational interventions (e.g., Maminirina et al. 2006, Richter et al. 2015). The majority of these NGOs' project descriptions, published in grey literature or on websites, focus on the UNESCO framework or its core attributes. To close the gap between global EE policies as promoted by the United Nations and national or regional practices first requires an understanding of the EE situation on the ground; baseline data are needed for tangible planning, implementation, and evaluation of the formal curriculum at primary school level (see for example Reibelt et al. 2014). In the present paper, we worked with a Malagasy NGO (Madagascar Wildlife Conservation, henceforth MWC) that promotes EE for lemur conservation (*Hapalemur alaotrensis*; Rendigs et al. 2015).

This study aims to (i) assess the usefulness of the UNESCO framework (awareness, knowledge, attitudes and skills) to guide EE research on the ground; (ii) explore whether advanced frameworks as promoted by environmental science might be

suitable to inform planners and practitioners of EE in the Alaotra, in order to professionalize formal and informal EE activities. We chose the theoretical framework of 'education *about, in*, and *for* the environment' (Tilbury 1995) to explore the suitability of this concept to bridge current practices with advanced theoretical thinking. The following sections will briefly introduce Madagascar's environmental, economic and educational situation, and provide details of the case study region including regional EE activities and evaluations. This is followed by the methodological section.

6.1.1 Madagascar and the case study region Lake Alaotra

Madagascar lies at the South-East coast of Africa and is recognized as a biodiversity hotspot. The fourth largest island of the world has a unique but highly threatened fauna and flora (Myers et al. 2000, Ganzhorn et al. 2001). It is renowned for its endemic lemurs (100% of currently 107 species; Schwitzer 2017), but also hosts at least 235 amphibians (100% of the native amphibians are endemic) and 363 reptile species (of which 92% are endemic; Glaw & Vences 2007, Vieites et al. 2009). Major biodiversity threats are overexploitation of natural resources, deforestation, and conversion of natural habitats, mostly by slash and burn agriculture. A crucial challenge for the country is to reconcile conservation efforts with local population needs, including poverty alleviation (Rakotomanana et al. 2013). Madagascar is one of the poorest countries worldwide with a population of 23.6 million people, 87.7% of whom live below the income poverty line of $1.25 (UNDP 2015). In 2030 projections, Madagascar belongs to the 11 countries with the highest risk of high numbers of impoverished people, multi-hazards (droughts, extreme heat, earthquakes, cyclones, and floods), and inadequate capacities to respond to these threats (Shepherd et al. 2013). Many international conservation and development measures have been implemented in the country over the past 30 years, but so far levels of success remain low (Horning 2008, Waeber et al. 2016). Education in Madagascar has a changeful history concerning structure, quality, and teaching language (details in Reibelt et al. 2014). Currently, mean years of schooling are 5.2 years, and 58% of young people do not graduate from primary school; public schools suffer from overcrowded classes as well as underfunded and undereducated teachers (Glick & Sahn 2006, Reibelt et al. 2014, UNDP 2015). Nevertheless, targeting primary schools for EE interventions ensures reaching out to the biggest portion of Malagasy children and attaining NGOs' aim to teach them at least some basic

knowledge on the environment, ecosystem services and sustainable development (Richter et al. 2015).

Lake Alaotra is renowned for its rice and inland fish production (Andrianandrasana et al. 2005). While the majority of the country's rice production occurs in the Alaotra basin around the lake, the marshes still host a number of endemic species such as the critically endangered Lake Alaotra gentle lemur (*Hapalemur alaotrensis*), known for its limited range (Mutschler et al. 2001, Ralainasolo et al. 2006, IUCN 2014). Growing human needs, dwindling fish catches and declining rice production, as well as increasingly deteriorating environmental conditions are exacerbating the search for more arable land (Ratsimbazafy et al. 2013, Waeber & Wilmé 2013). This frequently comes at the cost of the marshes that are crucial habitat for endangered species such as the mentioned Lake Alaotra gentle lemur (Waeber et al. 2017, Reibelt et al. 2017b).

To support regional conservation efforts, Durrell Wildlife Conservation Trust (Durrell) has run awareness raising campaigns (Andrianandrasana et al. 2005) and Madagascar Wildlife Conservation (MWC) has run an EE program in primary schools in 12 villages around Lake Alaotra (Maminirina et al. 2006, Rendigs et al. 2015, Richter et al. 2015). Despite these efforts there is only little EE in the public primary schools of the Alaotra region; Reibelt et al. (2014) provided a first general assessment of the school system in the region, including EE matters. The study showed that the region suffers from a lack of well-trained teachers and overcrowded classes. Teachers mainly apply banking education (sensu Freire 1970, Dewey 2004) and participatory approaches are largely hindered by big classes, lack of financial and technical resources, and time constraints. Furthermore, the lack of materials and training for EE hinder its implementation. Reibelt et al. (2014) also showed that, on average, EE was rated low in terms of its perceived importance compared to other school subjects. Similar results were reported by Dolins et al. (2010) who presented three conservation education projects from different regions in Madagascar. They reported that teachers mainly applied banking education rather than teaching styles that promote critical thinking. Their results further suggested the teachers had low awareness and knowledge levels regarding the environment, EE, and conservation. The authors also stressed the attitudinal barrier where low teacher motivation hampers the inclusion of EE in schools. They proposed introducing EE into the national school curriculum as a possible solution.

This is an approach that several NGOs in Madagascar are trying to implement. They pay teacher trainings and provide monetary and material support with the aim to integrate EE into (mainly primary) schools. For the present study, we worked with the Malagasy NGO Madagascar Wildlife Conservation (MWC) who has been running an EE program at Lake Alaotra since 2006 (Rendigs et al. 2015). The primary objective was to assess drivers and barriers of EE in the Alaotra public primary schools to implement effective EE strategies. The evaluation of MWC's educational comic book found increased knowledge levels in participating pupils compared to control groups without EE. Pupils that also used interactive learning material reached even higher levels of knowledge with longer-lasting effects on knowledge retention (Rendigs et al. 2015, Richter et al. 2015). Richter et al. (2015) showed that the additional educational material fostered peer-to-peer learning as opposed to teacher-centered education. They further stressed the need and positive effect of locally meaningful teaching material for EE.

6.2 Methodology

To explore the usefulness of the UNESCO framework for guiding EE research at Lake Alaotra, we developed a questionnaire that covered MWC's areas of interest without referring to a specific theoretical framework. Starting from this dataset, we further explored whether the theoretical framework of 'education *about*, *in*, *for* the environment' could support a professionalization of EE in the Alaotra region.

Fifty-four in-depth interviews were conducted in 18 primary schools around Lake Alaotra, with one director and two teachers per school. The schools were selected according to their vicinity to the marshes of Lake Alaotra, accessibility, school size, participation in an EE program provided by MWC (half of the schools had participated in such training, half had not), and school board recommendations. Data was collected from December 2012 to March 2013 using a standardized interview guide. The interview guide covered four major contexts with multiple sub-questions (the interview guide is provided in the Supplementary Material of Reibelt et al. 2014). The interviews covered questions concerning the village, school, natural environment, and teacher trainings. As described above, the questionnaire was specifically designed to support program evaluation and to answer the question 'what drivers and barriers exist to the implementation of EE in the Alaotra primary schools'. The motivation of the research team to choose

this transdisciplinary approach was to let practitioners drive the research agenda to obtain results that would be of greater practical relevance (Smith et al. 2009, Gardner 2012).

On average, interviews were 60 to 90 minutes long, audiotaped and then transcribed while translating from Malagasy to French. Interviewees were ensured anonymity and confidentiality, and their consent was obtained prior to audiotaping. At the end of each interview, biographic information was assessed via a questionnaire (see Supplementary Material in Reibelt et al. (2014)). A pilot interview guide was discussed with a Malagasy anthropologist from the region, and was tested after minor modifications in the local Malagasy dialect with 5 teachers. The questions and answers were translated into French to check for ambiguities in questions and translations. The iterative process helped to ensure methodological adequacy and cultural sensitivity of the interview guide. Ethical considerations during the entire research project followed recommendations as later laid down by Wilmé et al. (2016).

The interview transcripts were analyzed using a qualitative content analysis approach (Mayring 2003, Lamnek 2005). The analysis process included several steps. To begin, the first author read all interviews to screen for emerging topics per question. In a second step, three researchers (the first and second author, and a Malagasy researcher) screened four questions in all 54 interviews and each came up with a category system, based on their respective interpretation of the data. The three categorical systems were almost congruent and the little ambiguities were eradicated via discussion and agreement. This served to create a coding scheme that was used to summarize the interviewees' answers. In a next step, the three researchers coded the same 10 interviews with the computer assisted qualitative data analysis package MaxQDA, which also calculated inter-coder reliability, obtaining values higher than 0.9 (while a value of 1 would signify 100% congruency). After these initial steps and encouraged by the high levels of agreement, we followed the suggestions by Campbell et al. (2013) how one single knowledgeable coder can be "reasonably confident that his or her coding would be reproducible by other equally knowledgeable coders if they were available" (Campbell et al. 2013: 297). Hence, the first author created coding schemes for the remaining interview questions of interest, and the second author validated the codes. The first author then did the coding with MaxQDA. After coding, the

categories were translated into English before performing descriptive statistics using the statistical software R version 3.2.5 (R Development Core Team 2016).

All interview guide questions that touched on awareness, knowledge, attitudes and skills regarding the environment or EE were chosen for this study.

1. We examined *awareness* by asking teachers to
(a) describe the state of the marshes (classified as deteriorating at Lake Alaotra in the current scientific literature);
(b) mention the most important environmental problems in the region.

2. *Knowledge* about the ecosystem and EE was examined via the following questions:
(c) identify the local flagship lemur species (*Hapalemur alaotrensis*) from a picture, and share knowledge about it. Moreover, we asked teachers how they had acquired this knowledge regarding the lemur;
(d) teachers' definition of environmental education.

3. We examined *attitudes* by asking teachers:
(e) whether they discussed environmental issues with their social contacts (friends);
(f) to explain whether and why they judged EE (not) to be important.

4. As a proxy for teachers' *skills* we asked:
(g) to evaluate whether and how an afternoon dedicated to EE could become a success;
(h) about teachers' experiences on when their pupils participate best, in order to test for teachers' flexibility and adaptability of implementation of (environmental) education.

6.2.1 Study participants

Of the 18 directors and 36 teachers that participated in this research, 74% were women and 26% men, while 11% were aged below 30 and 54% above 50. The educational background of the participating teachers was as follows: 2% had primary education, 89% had attended secondary school and 9% a university before becoming primary school teachers in the Alaotra. The teachers had, on average, 21 years of teaching experience (median 27). The less experienced teachers were in their first year, and the most experienced teacher had been teaching for 40 years. With respect to EE, 43% of the teachers had received NGO

training at some point in the past 6 years, and 57% had never participated in such trainings.

6.3 Results

In the following section, please note that results are multiple response data obtained via open questions. The number of mentions (in %) are based on a participant number of n=51, as 3 transcription files were corrupted.

(a) Awareness: state of the marshes

Most participants generally displayed awareness that the wetlands suffer from environmental destruction and more than half of them (55%), without explicitly being asked, acknowledged that the marsh condition is deteriorating. On a 6-point scale, teachers rated the marsh condition as 'good' (12%), 'fairly good' (25%), 'fairly bad' (25%), bad (20%), and 'very bad' (16%); none considered it to be 'very good'.

> "I think the marshes are still good. People burned them before but then restored them. This is the advantage of the existence of the protection managers. The destroyers can do nothing; when there are fires, there is an alert, the fires are extinguished and afterwards the marsh is replanted; that is what we often do here." (Interview 43)

> "The marshes are shrinking; there are places where the marsh has already disappeared. They are getting destroyed, are filled with sedimentation, there is not enough water and the animal and fish species living there are no longer numerous. The marshes are fairly bad." (Interview 45)

> "The majority of the marsh seems to become rice fields; there are people burning them to establish rice fields. Their condition is very bad. Since this clearing takes place, the rain became scarce, and the water of the lake is drawing back." (Interview 28)

(b) Awareness: Environmental problems

The environmental problems in and around the 18 research sites can be grouped into three different categories, namely 'ecosystem', 'humans', and 'agriculture' (Figure 6.1). The ecosystem perspective entails destructive practices and their consequences. The human perspective mainly focusses on social or health problems in the villages, and the agricultural perspective comprises problems that decrease the output or income from agriculture (Figure 6.1).

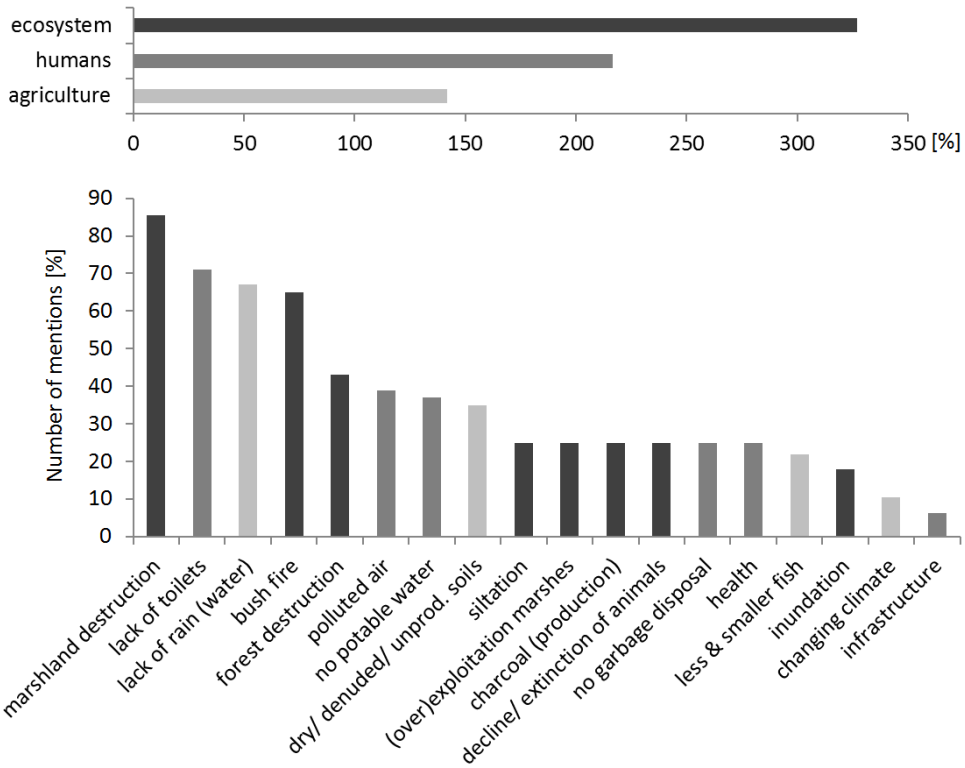


Figure 6.1 Environmental problems in the Alaotra region as perceived by the primary school teachers (n=51). Top: the problems are summarized into the three categories 'ecosystem' (dark grey), 'humans' (grey), and 'agriculture' (light grey). Bottom: sub-categories with corresponding shades to the top section.

Interestingly, most of the time teacher link mentions of the environmental issues (ecosystem perspective) with the resulting social impact (human or agricultural perspective):

> "The marsh is a natural wealth but it is being destroyed because people enter the marsh to seek their subsistence. There are also bush fires here. There is no rain because of climate change; it is already a sign of the destruction of the environment. Even in the rainy season, there is none and people are forced to destroy the environment for their subsistence." (Interview 40)

> "Agriculture is the basis of our community, but there is a decline in production because of the environmental degradation. It creates difficulties for the people because they become poorer. I don't know about the environment. For example, people make their living around Lake Alaotra, but now there are no more resources. The big problem is the destruction of forests for charcoal and board production. Everything is totally destroyed." (Interview 54)

> "The biggest problem here are the marsh fires; people also like to take the marsh vegetation to make baskets and mats. It's still an income, but it also destroys the marshes. And this story of bush fire: as a result, there is a lack of rain, because the hills are bare so there is no more vegetation that attracts rain and water is insufficient. So, the bush fire is the real problem here. Clean drinking water also does not exist here. Dirty water is drunk, wells are not very good and all the dirty drain water pours into the wells when the rain arrives but there is nothing to drink than that. Dirt is also a problem, because toilets do not exist, people do it everywhere and the dirt is very bad." (Interview 19)

(c) Knowledge: *Hapalemur alaotrensis*

Of the 54 participants, 61% identified the flagship animal (Lake Alaotra gentle lemur) from the photograph, 29% were not sure but guessed it correctly and 10% were unable to name it. The majority knew that the marshes are habitat for the lemur and that it exists around Lake Alaotra (Table 6.1). Aspects such as behaviour towards offspring were also prominent in interviewees' replies and half of the participants knew that the lemur is protected by law.

Table 6.1 Primary school teachers' knowledge of the lemur species *Hapalemur alaotrensis*.

Knowledge	Respondents [%]
Habitat	78
Distribution	78
Behavior	61
Protection	53
Diet	45
Threats[1]	37
Benefits[2]	37
Extinction[3]	24
Mammal	22
Reproduction[4]	14
Personality[5]	10
Domestication[6]	6
Other[7]	12

Note: Sample size n=51, average response number per person =5, range =0–8. [1]Threats include habitat destruction and extraction for bush-meat, sale, and pet-keeping. [2]Benefits from the lemur include food, tourists, and local richness. [3]Extinction includes total population being endangered or on a downwards spiral. [4]Reproduction includes viviparous, no eggs, twins, and monogamous. [5]Personality includes nice/ cute, malicious, and intelligent. [6]Domestication includes practices and ban on keeping the lemur in captivity. [7]Other includes color and weight, and monkey family.

Almost 50% talked about the lemur's diet (Table 6.1). Because half of the teachers had received EE training at some point where this topic had been addressed, we compared the answers to this question given by teachers with and without EE training. Misconceptions of food items such as lychees, insects, or bananas were held by 18% of the sub-sample (i.e., the 50% who talked about the lemur's diet), all of whom were teachers who had never received specific EE training from the local NGO. Of the 37% who had specific knowledge, such as names of the lemur's food plants, 32% were EE-trained and only 5% were untrained teachers. The remaining 45% of the sub-sample shared basic and unspecific knowledge, i.e., knew that the lemurs feed on marsh vegetation (18% were EE-trained, and 27%

untrained teachers). The lemur's diet was the only category where the knowledge of trained and untrained teachers showed a measurable difference.

Teachers stated that they acquired their knowledge of the locally endemic lemur species (*Hapalemur alaotrensis*) mainly from the media (35%), including multiple mentions such as books/ newspapers (20%), MWC's comic book (14%), posters (10%), radio (6%) and video projections (2%). With 29%, NGOs were mentioned on second rank; this included teacher training and awareness raising campaigns by MWC and Durrell. To a lesser extent, teachers mentioned social exchange (18%) and personal experience or observation (12%) as knowledge source (this category included lemur sightings in their natural habitat (8%) and as domesticated animals (4%). None of the teachers mentioned 'school'. On average, 2 sources of content knowledge were cited, with a range from 1–4.

> "I know this because I live in [village name] and from the MWC training, also thanks to their comic book and the poster." (Interview 1)
>
> "I learned this from posters and from radio broadcasts." (Interview 27)
>
> "I know all this from the awareness raising of Durrell [NGO] when their agents passed here to organize the 'radio crochet' [environmental competition between villages]." (Interview 30)
>
> "I learned all this by strolling in a boat at the bank of Lake Alaotra; there I saw the bandro [vernacular name of *Hapalemur alaotrensis*] jumping when moving around. It's wonderful to watch." (Interview 33)
>
> "I know all this from the tales of my grand-parents." (Interview 37)

(d) Knowledge: definitions of EE

Teachers mostly defined EE as conveying knowledge about the surroundings and environmental components:

> "For me, the environment is all visible; even the house, the soil, the air, the plants, the animals, the water, humans are part of the environment in my opinion. EE is raising awareness of people not to destroy the environment, i.e., not to make bush fires, the destruction of trees, marsh fires; the air should not be polluted but the water we drink must be protected." (Interview 29)

> "EE is teaching people about the environment, of what is natural around us." (Interview 39)
>
> "EE is teaching the children about everything that surrounds them." (Interview 52)
>
> "EE is teaching the pupils about the environment; included are the living beings, air and soil." (Interview 53)
>
> Some teachers also included the conservation aspect:
>
> "Environmental education makes children learn about what the environment means, its destruction and its protection." (Interview 37)
>
> "EE is educating the children about environmental conservation; to transmit to children the advantage of protecting the environment and the disadvantage of environmental destruction." (Interview 1)
>
> "To make the children know about what surrounds them, whether it is palpable or not, living or not, it must be protected because it is on this that life depends. EE is especially important here [at the primary school] because from their young ages these children will go into society and convince their entourage." (Interview 13)

(e) Attitudes: discussions with friends

The majority of our sample (82%) replied that they exchange with others on environmental topics, but 18% replied that they did not do so, or gave an inconclusive answer.

Discussions take place mainly with colleagues (37%), within the family (25%), and with community members/ society (24%), but also with pupils (16%), friends (6%), and others (16%) such as authorities (village chief, mayor), people at church, and specific professions (fishermen; average response number per person was 3, range 1–7).

> "I didn't discuss about the environment yet, but it is just a matter of conversation, like asking "what about the bushfires", but not in-depth debates." (Interview 53)

"Yes, I often discuss with my colleagues, but if one discusses with the people in the village, it can become a dispute because when I recommend them to respect the 'fishing closure' [a two-month period of fishing moratorium each year to allow fish stock recovery, generally characterized by financial shortage], they tell me that we have monthly wages while they have nothing. We discuss the environment here [at school], especially with the pupils; each time when there is the opportunity to talk to them about it, I do." (Interview 30)

"I discuss with the colleagues at work, about the garbage everywhere and the lack of latrines; we discuss what we can do about that situation." (Interview 33)

"In my family, we often discuss about it, because if we talk about cultivation, it leads to the environment that is destroyed even in the ozone layer." (Interview 15)

"Yes, particularly with the family, because we'll need to face environmental issues in the future. We must therefore talk about the inconveniences and what should not be done; with the colleagues as well. Often people do not know anything and they think that we just prohibit them to pursue their livelihoods." (Interview 39)

(f) Attitudes: importance of EE

Of the interviewees, 71% stated EE to be important, whereas 29% gave an inconclusive answer. The main reasons mentioned for the importance of EE were the protection and conservation of the environment (49% of respondents), the need for an intact environment for survival (41%), and knowledge about the environment in order to be able to play an active role in its protection (41%). Moreover, EE was judged to play and important role for health (35%), benefits such as the provision of present or future subsistence, including the utility of natural resources in every-day life, food, agricultural production, and natural or national richness (totaling 27%), climate (27%), maintenance which includes keeping the environment clean, respecting the environment and others' property, thus not destroying it (10%), development (8%), and others such as respect for the law, forming a new mentality, and informing society through school (6%; average response number per person was 4, with a range of 2–7).

In the following, representative quotes of the most prominent reasons for the importance of EE as mentioned by the primary school teachers are presented:

Conservation

> "They [the children] need to be aware of their contribution for the conservation of the environment from an early age, to improve the future." (Interview 4)
>
> "The environment is inseparable from us, that's why we teach the pupils about it. We ourselves will be the victims if we do not know how to conserve it." (Interview 14)
>
> "EE is needed so that people will protect the environment." (Interview 27)

Survival

> "In the field of agriculture and livestock, if by misfortune this environment is destroyed, what future is there for our descendants? Because this is what all life depends on. If the environment is destroyed, there will be no more rain for cultivation and what will we eat; and when the grasses do not grow anymore, what will the animals eat?" (Interview 15)
>
> "It is the environment in which we live. The environment is all living creatures and their surroundings. And if one of these is missing, it does not allow to survive; for humans, for example, and the living species." (Interview 19)

Knowing about the environment

> "EE is important because man doesn't know what surrounds him. What do I need to do about all the things with which I live on this earth? And he must thus be taught so that they don't destroy their surroundings, because it returns to them. His actions will always come back to him." (Interview 17)
>
> "There are many people who don't have the knowledge about the environment and they don't know that we need to protect the environment and they don't know the impact of the destruction of the environment; this is why we need environmental education." (Interview 27)

Health

> "Many plants are useful for the health and can be transformed into medicine." (Interview 11)

> "The reason why EE is important is that living beings depend on a good environment; their health depends on it." (Interview 44)

Benefits

> "Another important aspect of EE is reforestation; when the trees have grown big, they can be used for the construction of furniture, houses, etc. The prohibition of bushfires also shows the respect for the environment, to conserve grazing herbs for cattle, and to protect the soil from erosion." (Interview 48)

> "The importance of education is also that the child learns today the lessons he/ she will need as a grownup. Above all, to have good agricultural production so that earth may be far from famine if the environment is good." (Interview 17)

Climate

> "Facing all this, the change in climate, the increasing temperatures… in short: it is better to teach EE to humanity." (Interview 49)

> "Because the present climate change is due to the destruction of the environment." (Interview 31)

> "Bush fires cause precipitation to decrease." (Interview 9)

(g) Skills: developing an EE school afternoon

The idea of an EE afternoon (we chose afternoon so as not to interfere with the regular school schedule) was judged meaningful by two thirds (65%) of teachers, while 22% did not give a clear statement or said it would depend on what was done. The remaining 12% said that such activities would not be successful. The most common explanations were that a single afternoon would be too short a time, and that a long-term project would have greater impact.

Program suggestions mainly consisted of a single action or activity, with general suggestions such as sensitization, reforestation actions, or field trips without specific details. Only a few could envision specific activities and suggested more concrete details for plays and exhibitions, or field trips to the wetland with observation and activities to compare the state of the marshes in the past and today. Another detailed suggestion described a hands-on activity, i.e., an experiment to show how erosion works. All teachers proposed content or activities that they had experienced during NGO (MWC, Durrell) sensitization campaigns or trainings.

(h) Pupil participation

Teachers mentioned various contexts when their pupils participate best: apart from preferences for specific school subjects (67%), teachers cited teaching methods and strategies (47%) as stimulating pupil's attention and participation, and declared activating and hands-on methods as being favored by the pupils. Such methods included games, activities, art, handling of materials as during experiments, or oral participation such as rhymes, poems, and songs. Some mention that attention and participation depend on the individuum, i.e., the teacher or the child (14%).

On another note, almost half of the teachers (49%) mentioned the impact of hunger and fatigue. They stated that the children are more attentive in the morning (37%) when they are not yet hungry (18%) and that the children are in general less capable during the fishing moratorium (8%; average number of replies was 3 with a range of 1–7).

> "Especially during the fishing closure, the pupils are in trouble because many of them do not eat in the morning. We take advantage of the morning until 11am because the pupils are still in good shape during this time, but from 10am they start to be hungry." (Interview 28)

> "Every day before 10am, the students are more attentive but afterwards, they are not very concentrated anymore because they are hungry." (Interview 35)

6.4 Discussion

6.4.1 Global guidelines and local implementation

This study and the results by Reibelt et al. (2014) show that EE in the Lake Alaotra region is still in its inception. The extensive interview guide we developed for this case study allowed to gain insights into the situation in the villages, the school structure and organization, environmental problems, and teacher trainings. Using the UNESCO guidelines to assess the situation of EE in the region proved to allow a broad practitioner-oriented overview in providing useful guidance to explore teachers' attributes, i.e., awareness, knowledge, attitudes and skills towards the environment and EE, including an inquiry of teachers' skills to plan an EE intervention.

Our results show that more than half of the teachers are aware that the situation of the marshes is deteriorating. The teachers' main focus regarding mentioned environmental problems is their impact on humans, i.e., health and agriculture. Teachers know some general facts regarding the marsh-dwelling lemur, but experience from workshops indicates that knowledge regarding less prominent ecosystem components is more limited (unpublished data). Other studies showed that teachers tend to avoid or de-emphasize content that they are not confident about (e.g., Smith & Neale 1989). We hence infer that local environmental content is not widely addressed by teachers in the Alaotra primary schools. The fact that teachers' environmental knowledge is mainly conveyed via NGOs emphasizes the crucial role of the latter in raising awareness of environmental topics in the region (cf. Andrianandrasana et al. 2005, Rendigs et al. 2015, Richter et al. 2015). Teachers' definitions of EE mainly focused on the transmission of knowledge regarding the environment, i.e., knowing its components. This definition reflects the main teaching approach in Madagascar: the teacher-centered transmission of knowledge. Banking education is also present in many other developing countries with overcrowded classes and badly trained teachers (Bennell 2004). These countries in particular would need the implementation of approaches that develop critical thinking in learners, to educate people who can face and respond to future challenges regarding their subsistence livelihoods. This need is also reflected in the Alaotra teachers' evaluation that EE is especially important for conservation and survival. Nevertheless, compared to mandatory school subjects, EE was on average ranked relatively low and teachers thought there was already enough EE taught in school (Reibelt et al. 2014). The present

study results suggest that this may partly be due to teachers' definition of EE, but also based on their general attitudes towards environmental topics, as these do not seem to play a crucial role in social exchange. Despite moderate awareness levels regarding the environment, teachers favour subsistence over conservation values. This attitude seems to be common in the region, where high poverty levels mean that environmental problems are outweighed by personal financial or nutritional benefits, which confirms findings by Reibelt et al. (2014). This was also shown for local resource users (Waeber et al. 2017, Reibelt et al. 2017b), where fishers and farmers stated that as long as they have enough space for their livelihood activities, they do not mind conservation zones for lemurs and other biodiversity.

Given the economic and nutritional situation in Madagascar, this focus on subsistence does not come as a surprise. Madagascar ranks fifth worldwide regarding stunting due to child malnutrition, which affects 49.2% of children aged below 5 years (UNDP 2015). Even if the Alaotra is better off than many other regions in Madagascar, food shortage is also a well-known problem in the region. Especially during the fishing closure (when fishers are not allowed to sell fish, so as to enable fish stock recovery), households encounter a hunger gap (cf. Stoudmann et al., forthcoming). Reibelt et al. (2014) also reported that many pupils come from impoverished households and are malnourished. This poses a general barrier to education, as chronic malnutrition has negative effects on learning outcomes and school success (e.g., Wachs 1995, Behrman 1996, Brown & Pollitt 1996, Bradley & Corwyn 2002, Walker et al. 2007, Chinyoka 2014). Malnourishment results in poor performance, i.e., higher numbers of repeaters, or an increase in the drop-out rate (Arnold et al. 2007).

When considering teachers to implement EE activities, one need to ensure they carry the required skills, otherwise possible misconceptions or their own negative attitudes may rather harm than benefit the learning *about*, *in*, and *for* the environment. In the Alaotra, teachers shared very general propositions for an EE afternoon, most likely being activities that had been offered by NGOs where the teachers had participated in or heard about. This again indicates that NGOs offer new experiences to people (see also Reibelt et al. (2017a) for an example in higher education) but also indicates that NGOs could contribute to local capacity building in schools and of teachers by sharing their knowledge, experience, and access to EE material and methods. Many NGOs are 'system-external actors' who

are moreover in constant search for funds to secure their future work. It is beyond the scope and feasibility for them to support all (public and private) schools with EE. Despite the fact that NGOs are critical in raising awareness and increasing knowledge regarding ecosystems and their problems, as well as provide training for teachers in collaborating schools, most projects are timely and financially restricted (cf. Rendigs et al. 2015), thus unable to unfold their full potential.

6.4.2 Do educators in Madagascar apply a holistic teaching approach?

We were interested whether theoretical frameworks might be suitable to inform and guide EE practitioners in program design and implementation. The concept '*about*, *in*, *for* the environment' provides a theoretical and well-used framework for holistic individual development. It suggests that the three different educational approaches are needed so that individuals can develop the awareness, knowledge, attitudes and skills to contribute to sustainable living. It herewith provides a theoretical foundation and extension of the UNESCO framework that is still used by many NGOs.

In Madagascar, all three approaches do exist: (i) Education *about* the environment is integrated in the curriculum, e.g., slash-and-burn agriculture, erosion, fish reproduction, seed germination. Ormsby (2008) provides a list of further environmental topics in the Malagasy school curriculum, such as water courses, air, seasons, lakes, climate, and vegetation for primary schools, and advanced topics such as environmental protection, resource management, natural catastrophes, and food webs for secondary education. Moreover, NGOs carry out trainings, awareness raising events, and teaching in schools where knowledge about the environment, its problems and ecological linkages are addressed. (ii) Education *in* the environment is realized mainly with the support of NGOs and other external institutions, e.g., universities or researchers. This approach integrates visits of protected areas, mostly to see lemurs in their natural habitat, an approach also taken in the Alaotra region (Rendigs et al. 2015). (iii) Education *for* the environment is realized mainly as reforestation action, when community members or school children plant trees, for example during the World Environment Day.

The number of the above examples we were able to collect in this study indicates that the respective components of the theoretical framework (*about, in, for* the environment) are not addressed to the same extent in both the Alaotra region and in Madagascar more generally. Referring to the theoretical framework allows the conclusion that current EE practice in Madagascar mainly targets the development of knowledge (through education *about* the environment). Concern regarding the environmental situation can be promoted via education *in* the environment. Evidence from the Lake Alaotra region suggests that this is not necessarily restricted to educational interventions in formal contexts (Reibelt et al. 2017b); fishers who are in the marsh on a daily basis displayed the highest levels of concern about the future of the critically endangered Lake Alaotra gentle lemur as compared to other locals, despite the fact that they had the lowest educational levels (ibid). The third component of the framework focusses on learning while actively participating in preservation and improvement activities *for* the environment. Especially the third component has the potential to be practiced more widely in Madagascar, as it would improve the state of the (overexploited) environment, and may simultaneously have direct benefits on locals' subsistence if designed carefully.

In Madagascar, most people depend on the primary sector for their subsistence. With climate change, linked to extended droughts and increasing occurrences of cyclones, people will need adaptive capacity skills to respond to these threats. Another more recent framework is thus worth considering: Sterling (2010) explored the opportunities that lie in the consolidation of EE, sustainability and resource management. He argues from a resilience perspective about what is needed to obtain resilient socio-ecological systems. He calls for a reconciliation of the 'instrumental' and 'intrinsic' view of education. The instrumental view of (environmental) education focusses on external outcomes, i.e., the transmission of content to change awareness, knowledge, attitudes and values. On the other side of the scale, the intrinsic view is process-oriented, and focusses on the quality of the (learning or teaching) experience to educate critically reflective learners who are able to make informed decisions. While the instrumental (also called behaviorist) view is sometimes critiqued for its prescriptive character, the intrinsic view may lack direction as it is of second order only whether learners will decide to live in a sustainable or responsible manner (Sterling 2010). Sterling suggests that resilient socio-ecological systems need people whose education draws from

both paradigms, and proposes the integrative and transformative paradigm, which he labels 'sustainable education'.

When considering EE in Madagascar through this framework, it is evident that most initiatives can be assigned to the behaviorist view of education. Given the increasing rates of ecosystem destruction and biodiversity loss, organizations and institutions aim for immediate outcomes of education and implement the prescriptive approach of education. However, this focus on the ecosystem perspective risks leaving the people behind. They depend on ecosystems, and conservation can only be successful if their needs can also be addressed (Agrawal & Gibson 1999, Salafsky & Wollenberg 2000). One promising approach to reconcile the two educational paradigms is social learning (Sterling 2010, Gardner 2012). This concept emerged in the context of natural resource management and focusses on collective learning of various stakeholders in complex systems, and could as such also offer a helpful tool for community-based conservation projects in the country (cf. Reibelt & Nowack 2015, and references therein). Social learning acknowledges that transmissive teaching or learning is insufficient in complex systems that are faced with uncertainty and change, and develops adaptive capacity in learners (Folke et al. 2002, Armitage et al. 2008). Building local capacity in Madagascar by improving communication between and among researchers and practitioners is crucial if EE is to leave its infancy status and 'grow up' to support conservation and development.

6.5 Conclusions

EE in Madagascar is mainly realized by conservation NGOs and as such regarded as a means to support conservation action. Global policy guidelines guide practitioners in EE implementation, but the example of Lake Alaotra shows that EE teaching encounters various structural and educational barriers. In order for EE to be more effective on the ground, capacity building is crucial to bridge the researcher-practitioner divide, both on an NGO as well as on a teacher level. Theoretical advancements that foster holistic teaching of EE appear to be promising to the achievement of tangible benefits both for the environment and the population on the ground. However, promoting adaptive capacity in learners on all levels (NGO, teachers, pupils) requires participatory approaches and not 'just' the provision of preconceived material and training. Instead, expertise of locals, EE practitioners, and researchers needs to be considered, and critical

thinking to be promoted. This would allow valorization and advancement of locally existing capacity and vocation, and would allow researchers to provide tangible benefit with their research to the settings they engage in. Supporting system-internal capacity and considering cultural background and local needs will increase the chance that locals in socio-ecological systems will be able to sustain ecosystem functions when coping with change in the future.

Chapter 7

Life paths of Malagasy conservationists and environmental educators

Abstract. In a globally fast-changing world, dedicated conservationists play a central role in societies moving towards the achievement of sustainable development. How do people become advocates for nature? Research suggests that childhood experiences in natural places are core determinants for the development of environmental stewardship. In many developing countries, however, access to intact natural environments is limited. This study explores formative influences on individuals who actively contribute to nature conservation and environmental education (EE) in Madagascar. We conducted nine semi-structured interviews with participants in a national EE workshop. Formative experiences were reported mainly from university years, and influential persons were researchers and high school teachers, many from abroad. The media also play a considerable role, while negative experiences, familial influences, or experience of natural areas during childhood were rarely mentioned. In contrast to former studies, the results suggest that direct experiences of nature can still be decisive in determining a young person's path as a dedicated environmental practitioner during young adulthood. Role models who are active in the conservation and sustainable development fields can compensate for a lack of familial models. These findings might require a rethinking of current educational practices in Madagascar because children might not be the only important group to target with educational interventions.

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7.1 Introduction

To support the efforts towards global sustainable development, there is an increasing need for dedicated conservationists and educators worldwide. This leads to the question of what kinds of experiences are key to the formation of advocates for the environment. A wealth of research has been done on significant life experiences, also called formative events. This research is based on participants' memories; they share the experiences they consider important in retrospect, be it their choice of conservation work (Tanner 1980, James 1993), attitude towards the environment (Sward 1999), interest in or concern for the environment (Palmer 1993), or commitment to environmental protection (Chawla 1999). All studies found similar patterns: time spent outdoors or in pristine environments during childhood seems to be one core determinant for developing interest in the natural environment and its conservation. To date, all studies on formative life events have supported Tanner's hypothesis that a child must first come to know and love nature before he or she can develop concern for its state or the wish to care for it (Tanner 1980). During our research on environmental education in Madagascar, however, personal communications suggested that most Malagasy do not have the opportunity to experience pristine nature and form positive bonds towards it during childhood.

With its high rates of plant and animal endemism, Madagascar has been identified as one of the "hottest hotspots for biodiversity" (Ganzhorn et al. 2001). At the same time, natural forests and biodiversity are increasingly threatened, and destruction of natural habitats, ecosystems, and forest patches are a daily occurrence. The subsistence needs of local farmers are one of the reasons why natural areas are transformed into agricultural land. Madagascar figures amongst the poorest countries in the world, ranking 154th out of 188 countries listed on the Human Development Index, a composite measure which includes health, education, and living standards: of the 23 million inhabitants, 88% live below the poverty line of 1.25 USD a day and many depend on subsistence agriculture (UNDP 2015). The consequences of colonization and the *malgachisation* of teaching (an attempt to eradicate post-colonial influences with the abolition of the French language, and the introduction of an official Malagasy language, which resulted in the severe deterioration of the quality of schooling; for further details see (Reibelt et al. 2014), and references therein) are still present in the school system, which struggles to educate the Malagasy. Fifty-eight percent of youth

aged between 15 and 24 have not completed primary education, and only 2% are enrolled in post-secondary education (EPDC 2016); most worrisome, only 19% of primary school teachers are trained to teach (UNDP 2015). The island has received extensive international donor attention (Waeber et al. 2016) in an attempt to end poverty, improve education, and protect wildlife and ecosystems. To date, however, the rampant poverty levels still undermine conservation efforts in the country. Recent studies showed, as expected, that locals value subsistence and agricultural output over conservation (Reibelt et al. 2014, Waeber et al. 2017). One of the reasons, other than poverty, for this attitude is that most Malagasy aren't aware of the biodiversity and conservation values of their country.

As an example, in the Lake Alaotra region of Madagascar, primary school teachers were asked about the environmental problems in their neighbourhood. They were rather concerned about the social environment, and were interested in natural issues only when these had direct implications for agriculture or other (immediate) livelihood issues (Reibelt et al. 2014). Due to the teachers' lack of knowledge and awareness of environmental problems and their causes, the regional ecosystems and endemic species are not addressed in most primary schools in the region. Despite the vicinity of lake and marshes, most school children have never seen the locally endemic flagship species *Hapalemur alaotrensis*. An evaluation of the environmental education programme by Madagascar Wildlife Conservation revealed that less than a fourth of primary school children had ever seen a lemur. This number already included children who had seen lemurs in books (18%), in a zoo (7%) and as pet lemur (4%); only 6% of the participating primary school children had seen a lemur in its natural habitat (Richter et al. 2015). Generally, only few Malagasy have ever seen a lemur in the wild (Dolins et al. 2010), and most Malagasy children do not learn about biodiversity at school (Ratsimbazafy 2003). Apart from school, non-governmental organizations try to raise awareness about the country's biodiversity and the threats against it. Criticism has evolved that some NGOs might impose western conservation values on Malagasy learners, without acknowledging local and regional ethics and beliefs. Madagascar has a wealth of beliefs, both religious and spiritual. Local and regional taboos, called *fady*, and the belief in good and evil spirits intervene in daily life (Golden 2014). The evil spirits in particular are believed to dwell in the forest, rivers and caves. As a consequence, the environment is sometimes perceived to be "a place of reverence and trepidation" (Golden 2014). The combination of subsistence, poverty, and the complex belief

system shape the lives especially of rural farmers. This results in a different perception of the environment than that of western conservationists who focus on biodiversity values. In addition, access to both formal and informal education is limited, and awareness of the country's peculiarities is not common in the population. A leading Malagasy primatologist stated that it was not until university that he learned about lemurs (Ratsimbazafy 2003), and yet he is one of the most dedicated Malagasy researchers and conservationists. Indeed he is not the only one; others work hard to achieve conservation and sustainable development in the country, including environmental education. When thinking of future conservation and education interventions in Madagascar, what kind of capacity building interventions could have the most impact while at the same time respecting local values and beliefs?

Previous studies suggest that childhood play in natural settings is one core determinant to develop interest or stewardship for the environment (Tanner 1980, Palmer 1993, Chawla 1999). These studies were all conducted in industrialized, Western countries. In view of the discrepancy between available research on formative events and the information we obtained from personal communications in Madagascar, we were interested to see whether the practitioners in Madagascar had any formative experiences other than childhood play in natural settings. We aimed to find out how and why they became advocates for the environment in order to possibly inform the conservation and sustainability sector about measures which might be taken to increase environmental awareness in future.

A review of the existing literature on formative life events for conservationist careers showed the publications by Chawla (1998a, 1998b, 1999) and Palmer & Suggate (1996) to be of particular use for our study. (Chawla 1999) provides an elaborate presentation of the eleven distinct categories she used for her study sample of 56 environmentalists from Kentucky, USA, and Norway. She found that, similar to other studies, childhood experience was the most important source for the environmental commitment of her study participants. More than half also mentioned family and organizations, while negative experiences such as the destruction of nature, and education or the influence of friends were mentioned by more than a third to have played a crucial role. Less than 30 percent mentioned vocation, a sense of social justice, a book or an author, principles or religion, or concern for (grand) children (for explanations of the categories, please

see Supplementary Material 7.1, p. 174). While categories varied, similar patterns have been reported by various studies from other high income countries (Tanner 1980, Palmer 1993, Palmer & Suggate 1996). Chawla (Chawla 1999) further found that some individuals' actions were driven by love of nature, while James found that more than half of his sample (*n* = 50), who were Americans with multiracial backgrounds, mentioned job opportunity as a reason for their career choice in environmental education (James 1993) (Chawla 1999). This was in line with an earlier finding that individuals' life courses are a mixture of personal interests and the opportunities life offers; these sometimes change interests and can turn people's energies in new fields and directions (Bandura 1982). Based on these insights, we developed our semi-structured interview guide; a description is provided in the methodological section.

Research continues to address the question as to what formative childhood experiences determine environmentalism in adulthood (Wells & Lekies 2006, Chawla 2006, Payan 2012)). Bearing in mind the different cultural, educational, and economic context in Madagascar, it is important to ask what pathways into conservation and environmental concern exist in the country. In this explorative study we aim to identify the formative experiences and persons Malagasy conservationists judge important in retrospect.

7.2 Materials and methods

Structured open-ended interviews were conducted during a national meeting of leading Malagasy conservationists and environmental educators in Toamasina in 2015. We conducted one-to-one interviews of about 30 minutes in length (min. 19, max. 46) with 9 workshop participants. Study participants were chosen based on the recommendation of a leading conservationist, and availability. The interview guide contained an introductory section with background questions on age, gender and level of education; the open questions asked for formative experiences and persons, whether their choice to work for the environment was driven by love of nature, and whether they had entered their profession by chance or active choice. The interviews were conducted in French by the first author, and informed consent was obtained prior to audiotaping. The interviews were transcribed and then analyzed with MaxQDA 11, also by the first author who had spent extensive periods in the field, first-hand experience of the context being crucial for a holistic understanding and interpretation of the interview

statements. The statements that are shared in this manuscript were translated into English after the analysis had been completed, and only slightly edited to preserve their character and ensure reliability and authenticity of our results.

Analysis was based on a categorical system that was established by using both an inductive and deductive coding approach (Mayring 2003, Lamnek 2005) in an iterative process. We considered the categories found in reviewing the literature on significant life experiences; a main critique of former studies was that they did not produce comparable results due to inconsistent categories of analysis (Chawla 1998b). Based on our data, we decided to follow the categorical system and code definitions of Chawla (Chawla 1999), which are based on an extensive review. To better represent our data, while still ensuring comparability, we added further categories as listed in Supplementary Material 7.1, p. 174. We ensured reliability in our study by being conservative in interview analysis (Tanner 1980), i.e., by "scoring only those responses to which explicit or prominent references were made" (Palmer 1993) (p. 27). In the results section, descriptive statistics (mainly percentages) are used to present the number of mentions of each category, and subsequently, exemplary citations from the interviews are given.

7.3 Results

The age of the participants ranged from 25 to 62 years; two were below 30, four below 50, and three were older than 50. Of the 5 men and the 4 women, the lowest educational degree was a high school diploma (1), the highest was a post-doctoral qualification (1); the remainder were PhDs (2) and Masters (5) in Plant Biology, Anthropology, Geography, Agronomy, and Conservation Biology. The range of mentioned formative aspects was 1 to 5 (median 2); when including multiple mentions, the range was 2 to 7 (median 3); all participants thus mentioned several sources for their interest in the natural environment.

7.3.1 Main stimuli that awakened interest in the natural world

The one main influence that Malagasy conservationists and environmental educators recall is education, which comprises the influence of educators and field trips. Other major influences are the media, i.e., books and television, and travel. Organizations, negative experiences, friends, and social justice were mentioned by one fifth. The data are summarized in Table 7.1 and showcased in more detail in the following sections.

Table 7.1 Sources of interest in the natural environment mentioned by Malagasy conservationists and environmental educators (% mention rate; n=9); categories based on Chawla (Chawla 1999) and Palmer and Suggate (Palmer & Suggate 1996)*.

Sources	Mention rate [%]
Education	**78**
Setting/Field trip	*78*
Persons	*67*
Media	**44**
Book or author	*33*
Television	*22*
Travel	**44**
Organizations	**22**
Negative experiences	**22**
Habitat destruction	*22*
Pollution, radiation	*0*
Friends	**22**
Sense of social justice	**22**
Family	**11**
Parents	*0*
Others	*11*
Experience of natural areas	**11**
Concern for (grand)children	**11**
Vocation	**0**
Principles or religion	**0**

*The main categories are shown in bold, sub-categories in italics; see Annex 1 for definitions of the categories.

Education. This aspect influenced 78% of study participants. More specifically, field trips during university courses were considered by 78% to be crucial for the development of interest in the natural world, as exemplified by the following two statements:

> "I remember it was especially during my university studies, […] when I was in the 4th year, they took me to travel in the forest of 'Montagne d'Ambre' [National Park] and I believe this is the experience in the environmental domain that I liked the most in my life, because it's discovering something else, discover forests, waterfalls especially, and the sea. It is then I think where I started to love nature."

> "When I was in the second year, we made an excursion to Andasibe [National Park]. And this was the first time in my life that I saw the lemurs in their natural habitat. And one of our professors explained a lot, the role of lemurs, their importance, and from then on, I started to be interested in biodiversity, especially the endemic biodiversity of Madagascar."

One participant specified that the confrontation with reality was an awakening experience:

> "It started in 1999, we finally went to university, I was already in the department of Palaeontology, we learned... but... the fact of going into the field to see the things in the forest, that's different. Learning theoretically, and seeing reality, that made the difference. Yes. Because we learned as in school to get good grades and to pass exams and that was the most important thing before. But after this experience it was different."

The above are examples of statements showing that most participants judge excursions during their studies at university as crucial for their love of and interest in the environment. Only one participant remembered an influential nature experience during primary school; he described the excursion they went on at the end of each school year:

> "I remember I enjoyed it, because when we had an excursion or picnic we used to come to a place like that [picnic area with tree plantation]. So I feel, I saw the difference like coming from town to go to a place like that, even if it's not too far from Tana [the capital Antananarivo]. But I've

> noticed there is a big difference, much better air you can get and the fresh water, just to see that. So I started to be more interested in that."

Sixty-seven percent mentioned inspiring teachers who influenced their interest in the natural environment. Interestingly, amongst the influential persons, a remarkable proportion comprised foreign researchers (44%, or 67% of the sub-sample).

> "People from Missouri Botanical Garden. They are international researchers, such as Dr. Chris Birkinshaw, Dr. Pete Lowry, mainly these two persons."

> "Patricia Wright was among the people who influenced me. She discovered new species and has always talked about this discovery of new lemur species, so it is really something to discover!"

> "It was especially Alison Jolly, but later it also was the passion of the students, and their involvement. This pushed me further. Because when I saw that they were interested, that pushed me even more to get involved with them, to continue, thus supporting all their actions."

One interviewee aimed at becoming as popular as the role models:

> "I had fallen in love with lemurs, not only their beauty, but their importance too, so when I learned the importance of primates, I thought: for the pioneers for the gorillas, it was Dian Fossey, for the pioneers of chimpanzees it is Jane Goodall, and in Madagascar it was Allison Jolly. And I dream for me, wow, why not, one day, I will be famous too, not just famous, but somebody important contributing to the conservation of biodiversity."

Similarly, another person was inspired to contribute to research as an independent individual in a leading position.

> "I was a student at a non-governmental organization when I made my DEA [equivalent to Master's degree] and there we communicated with international researchers and I said to friends and colleagues, 'I'm Malagasy, so when I do my research, I'd like to become the investigator one day but not always only the assistant'. It is like a challenge."

The remaining 22% (33% of the sub-sample) mentioned Malagasy professors, and one interviewee mentioned a guide in a National Park who worked with the university:

> "There was someone who was a guide in Masoala at that time. And he knew all the species, but only their name in Malagasy, and he taught us a lot […], he opened us towards other species, the lemurs and frogs, and all this, and what I remember very well of him, he taught me the smells of the forests, and also the noise and he told me when the birds stop singing, that it will rain […]. And he also taught me that when the frogs are croaking, it means that the weather will be fine and you can stay as long as you want to in the forest. I think he really is an expert, but with his local knowledge, not translated into scientific knowledge."

All participants mentioned several influential persons (range 2–4); if multiple mentions are included, the percentage of influential teachers increases from 78% to 189%. Of these, 44% were non-countable mentions, e.g., international researchers, foreign students, or tourists.

Media. The second most important significant influence on our sample was the media (44%) which includes books or magazines (33%) and television (22%). For example:

> "I think the one experience that I got is when I went to the library and was just reading a book containing all the stuff that I saw for the first time; to see all the animal pictures and plant pictures sparked my interest in nature because I never had the opportunity to get to a forest when I was in Tana […]. And after that I tried to, want more, to see animal reports, documentaries, to try to ask my mum to take me to the zoo or something like that."

> "When I was little, I was already interested in the environment, it was already something I was passionate about, I love nature and everything. I liked books very much already, but there was the magazine 'Vintsy', so I learned a lot from this magazine."

Travel. In our study, 44% mentioned having visited one to three foreign countries during their studies and career. All but one stated directly or indicated indirectly

that they had travelled a lot in Madagascar thanks to their profession. Two examples of trips abroad and their impact are provided below:

> "And then in the fourth year I participated in the TBA, Tropical Biology Association field course and I was in Uganda, and there too we learned a lot of things, biodiversity of Africa in general, plants and all that, and that also prompted me to become responsible because the endemic biodiversity belongs to Madagascar and as I'm Malagasy, I feel responsible to participate in the conservation of Madagascar."

> "When I was a child, I was afraid of animals. I was afraid of chickens, cats, yes. That's among the Malagasy, most Malagasy are afraid of animals. But when I was 19 years old I went to Russia […] to learn breeding of domestic animals. And it's there I learned to love animals."

Organizations. Two participants described how the active involvement in a specific NGO allowed them to develop and broaden their interest and knowledge of the environment.

Negative experiences. Reports of negative events were low (22%).

> "In the Department of Paleontology, we were looking for fossils, we went to the forest and we found traps, captured lemurs in the traps… so that's urgent. It was necessary to 'switch', i.e., the fossils can wait in the ground and we must save the living."

> "Seeing the degradation that exists all around in our environment. After that, it was from reading books, as I said."

Friends. These were influential for 22%, e.g., in the choice of specialization, and during the course of studies:

> "When I was in the fourth year it was peer influence. It's very weird. So, my friends were saying "Ah, I'll do this, I'll do that, and you, what are you going to do?'. It's not, what do you WANT to do, but what WILL you do. And everyone said that botany is interesting and afterwards there is something to do and I chose botany."

> "We were a group, a group of young students. We were five people, each one with his specialization, the lemurs, reptiles, birds and all that, who

> formed a group. And I met these passionate people around me who gave me courage, and who made me love the profession we do."

Sense of social justice. Two interviewees stated that they were concerned about the wellbeing of the Malagasy population, and that conservation work was a means to improve their lives:

> "I'm not a pure conservationist to say: the plant is the most important thing, it is not that. For me, if you are studying plants, to do plant conservation, it is mainly for humankind. So I started to think that working in environmental conservation, plant conservation, is for human development."

> "In fact what I wanted to do was rural development. I didn't and don't want to leave the rural setting, but to improve it. And that's why I chose agronomy as my field of study. Because most of the time the farmers, the rural people, they are poor."

Family. Not a single interviewee mentioned their parents as having awakened their interest in nature; one of the younger participants even stated:

> "No, on the contrary, people tried to influence me to choose another field such as medicine, but I was not interested in that."

Furthermore, studying the natural environment or animals did not have a good reputation until some years ago:

> "My parents don't have any background at all regarding animals. By the way, before, in Madagascar, studying animals… this was silly, especially the animals of the forest. I still remember that there were situations when we talked about the forest: these are bad things, bad spirits, so working in the forest that's where there are bad spirits. It was not my parents but in general people talked like that."

Experience of natural areas. An influential nature experience during childhood was described by one study participant:

> "And then my parents, during holidays, we did not travel, but we went to the countryside, and one does not have this feeling of being enclosed in a house, in a yard, but one has the feeling of being free. It may be this that I

liked back then and what I later found in the forest again... as we were so free."

Concern for (grand) children. One participant, a parent, was concerned about the children of tomorrow:

> "It is for love, and... well, it is in view of the situation […]. I said: oh, what is the future of the next generation? So, in view of the state of biodiversity, what needs to be done, so there is a very urgent need to conserve that."

As specified in Supplementary Material 7.1, p. 174, the definition of the category "experience of natural areas" excluded one-time stays of adults, but focused on childhood experience and regular leisure time activities only. We were tempted to broaden the definition, but retained it for comparability reasons. However, to cover the excluded aspect as well, we re-analyzed the data with a broader definition of nature experience, including all stays in natural settings, also non-regular exposure to natural surroundings in adulthood. With this categorization, a majority (78%) of our sample had intense experiences of nature, either during their university studies, or in research projects shortly thereafter, i.e., all during young adulthood.

7.3.2 Choice of profession

Independent of influential experiences and persons, interviewees were also asked whether their choice to work for the environment was driven by love of nature. Fifty-six percent stated that love of the environment had influenced their career choice:

> "I think it really was love of nature and a vision of freedom I have in nature. And it is later that I began to understand that people depend on nature. The value of biodiversity, the practical value of biodiversity and everything, that everyone, all life depends on biodiversity."

The remaining 44% ascribed their choice not to love of nature, but to the following:

> "As I said before, there was already this passion, so maybe it was pushed by the context I was following, developing awareness, so more passion and more awareness."

> "A combination of two things. Even if it is not by love, but by conviction […] and by seeing the reality of the people."

> "Love of my home country. Love of country, because the country is really the people, the population […]. Everything together, not only nature, but all together."

We also asked whether the choice of their profession had been an active choice or whether they entered this path by chance. Sixty-seven percent stated that it had been an active choice to enter the environmental field, while for 33% it was by chance:

> "Well, it's a bit difficult to explain this, but you know in Madagascar, opportunities for work are very limited. So you have to take the opportunity if there is one. You have to love and you must develop it."

7.4 Discussion

This study provides a first explorative assessment of formative experiences that awakened the interest of Malagasy individuals in nature. The data presented here showed similarities with results presented in former studies but some striking differences were also revealed by the current research. Education was ranked as the one main influence. The minor role of childhood natural area experience was surprising, as was the fact that family was not given a dominant role by the participants of this study. On the contrary, family influence was negative in some cases or the family tried to discourage the individual from seeking a career in conservation. These outcomes stand in contrast to many former studies that identified nature experience in childhood and influence of parents as determinant factors (Tanner 1980, Palmer 1993, Palmer & Suggate 1996, Chawla 1998b, 1999, 2006).

7.4.1 Higher education offers new perspectives

Field trips in the second or fourth year of university studies were formative experiences for the majority of the Malagasy interviewees independent of their study subjects, which ranged from Anthropology to Geography. Some participants mentioned that they did not learn about lemurs or the biodiversity of Madagascar until they went to university, a fact also mentioned by Ratsimbazafy (Ratsimbazafy 2003). Similarly, Palmer (Palmer 1993) found that for some participants in her study, a concern for the environment did not develop until they participated in higher education and adult courses.

At the same time, teachers in the broader sense played an important role as well. In our study sample, the main influences seem to come from foreign researchers who are working in Madagascar. Collaborations of foreign researchers with Malagasy universities offer the funding and opportunity for students to learn and gain experience in the field and to travel, i.e., to get to know new perspectives. These collaborations also include contact with western researchers and their values. The influential Malagasy role models were mostly teachers at university who were in regular contact with foreigners, or had lived abroad for some time.

Since Madagascar's independence in 1960, external donors and conservationists have continued to shape policies, projects and decisions (Waeber et al. 2016). Many foreign NGOs support and implement conservation and development programmes. Criticism has evolved that the activities promote western values rather than incorporating local knowledge, needs, and values. Given the high importance that participants of the present study give to foreign researchers and conservationists, we call for a more elaborate view. We agree that top-down conservation which imposes western goals on local communities is not the way to go (Scales 2014b, Reibelt & Nowack 2015, Rendigs et al. 2015). However, we still think that Madagascar can profit from external, pro-conservation perspectives. These might broaden knowledge, approaches, and (funding) opportunities, and finally facilitate the formation of a "Malagasy way" towards a sustainable balance between conservation and development. Some participants of this study described how their travelling to other countries has changed their awareness and attitude towards the biodiversity, the endemic plants and animals of their own country. The trips within the country also helped to broaden their horizons, and to help them get to know what the island originally looked like.

To make our point clear, we further stress that the role of family or parents in our sample is non-existent. Studies from industrialized Western countries found that attitudes and actions of family members were crucial to develop interest or positive attitudes in nature (Palmer 1993). If family attitudes are crucial, it is worth taking a closer look at the social and cultural constructs in Madagascar. For the general public, the natural environment does not seem to carry positive connotations; forests are widely considered to be ominous places where bad spirits may wait for visitors (Golden 2014). Some forest animals such as the lemur species *Daubentonia madagascariensis* or Aye-Aye is believed to bring evil (mostly disease or death to someone in the village it enters or passes), and is often killed when seen to fight the bad fortune it is believed to bring to people (Simons & Meyers 2001). In the South, the tortoise *Geochelone radiata* is *fady*, i.e., consumption is prohibited by a taboo, because it is considered dirty by the local people (Lingard et al. 2003). Depending on the region, different lemur species are *fady* and not allowed to be eaten, e.g., *Indri indri*, or *Propithecus verreauxi* (Mittermeier et al. 1994), and chameleons generally have a status between being respected and feared on the island, because they are considered to be connected with powerful spirits (Ramanantsoa et al. 1984); for an overview of good and bad spirits and their connections with *Zanahary* (God), see (Golden 2014). Each region has different *fady*, but due to migration, taboos are followed less and less today. While immigrants do not generally follow the local *fady*, respect for the ancestors still sustains many of the taboos. The ancestors generally play an important role in daily lives, and the social system is hierarchical, i.e., ancestors are the most powerful, while the elders are the leaders of communities and can act as a communication channel between people and their ancestors. Younger persons are not in a position to question or criticize older persons or traditional practices. For traditional people, changing their way of living would be an insult to their ancestors (which these may punish in consequence). With increasing migration, travel activities, and visits by foreigners, existing traditional worldviews may be increasingly questioned. This can have implications for conservation issues, but more essentially cause change in Malagasy society. This is a struggle which especially the younger generations will have to deal with.

7.4.2 Several day excursions as transformative experiences for young adults

Memorable experience of natural areas as defined by Chawla (Chawla 1999) was only shared by one person, who experienced a feeling of freedom during her childhood visits to the countryside. Chawla & Cushing (Chawla 1999) reviewed several studies and summarized: “from half to more than 80% of the respondents identify childhood experiences of nature as a significant experience, such as free play, hiking, camping, fishing and berry picking” (p. 3). None of these activities were mentioned by our respondents.

However, our study revealed that a majority of our sample had intense experiences of nature in young adulthood. The participants vividly described how these experiences changed their way of looking at the world. In Madagascar, more or less intact ecosystems are mostly restricted to protected areas such as National Parks that most Malagasy people do not have the opportunity to visit. Giving the young people the opportunity to experience a stay in these pristine environments seems to be a crucial game changer in Madagascar. This point of view was also shared by Palmer and colleagues (Palmer et al. 1998) who stressed the “overall tremendous importance of direct experiences in the natural world” (p. 454). Many previous studies have identified childhood experience of natural areas as crucial experience (Tanner 1980, Palmer 1993, Palmer et al. 1998, Chawla 1998b, 1999). Our study did not confirm this for the Malagasy conservationists. However, despite the lack of such childhood experiences, they are actively involved in conservation and environmental education activities. Our study suggests that the experience of pristine nature can still have tangible effects in young adulthood.

Both education and nature experience during adulthood amount to 78%. Basically, these categories are almost congruent. This reflects reality in Madagascar; most Malagasy children and adults do not have access to experiences in natural environments or parks for financial reasons, i.e., they can afford neither transportation costs, nor entrance or guidance fees. Furthermore, the value of visiting such places is not promoted as it is in western culture. The environment is regarded from an anthropogenic perspective by most Malagasy who depend on subsistence agriculture (Reibelt et al. 2014). However, our study participants all belong to the 4% who finish secondary schooling, and who have the chance for in-depth studies and are therefore part of a small educational elite.

Similarly, the ethnicity of American Middle school students and the income of their counties influenced their environmental knowledge levels (Stevenson et al. 2014). Our study participants are an exception in the country in that they had the opportunity to participate in trips to pristine nature areas. Besides their educational levels, their economic status allows them to make a choice.

7.4.3 Negative experiences

Negative experiences did not figure prominently in our sample. This comes as a surprise, as the majority of forests in Madagascar have been destroyed and have changed into large landscapes covered by infertile dry grasslands, and erosion gullies are a common feature of hilly landscapes. Thus, the destruction of the natural environment is pervasive. However, for most people, the agricultural environment is the only "natural" environment they know. Moreover, this lack of negative experience may be explained by the fact that most study participants were from the capital, far away from forests. A study in villages around the National Park Ranomafana suggested that pupils who lived close to recently deforested areas were more aware and concerned about environmental destruction than children from forested areas. On the other hand, the closer children lived near the National Park, the more aware of environmental destruction they generally were (Korhonen & Lappalainen 2004), probably due to increased educational interventions. A similar pattern was found around Lake Alaotra, where local resource users' environmental knowledge and awareness levels decreased with increasing distance to a special conservation zone (Waeber et al. 2017). Chawla (1998b) hypothesized that future activists may mention childhood experiences as a formative factor less and less as time passes, due mainly to a decreasing availability of natural places. At the same time, it was suggested that negative experiences as motivating factors would increase (Palmer & Suggate 1996, Chawla 1998b). Our study does not confirm this. Childhood experiences do not play a major role in the examined context, nor do negative experiences figure among the prominent reasons for becoming interested in the natural environment. Further surveys are needed to assess whether the virtually inexistent mention of childhood experience in Madagascar is related to cultural or historical reasons, or whether this is related to the "new generation" of activists that were predicted by previous publications. The good news, however, is that advocates for the environment can also develop without these childhood experiences.

7.4.4 Working for the environment: between vocation and chance

Reasons and motivation for working for the environment varied in our study. For some participants it was an opportunity to earn money, and some had entered the profession by chance. James (James 1993) (Golden 2014) conducted interviews with environmental educators from multiracial backgrounds to understand the reasons for their career choice. He was the first to introduce the category "job opportunity", which ranked second after outdoor experiences and mentors. While this was also mentioned in our sample, somewhat more than half of the participants still stated that they had made an active choice. They were motivated to very passionate about their work and some would not want to do anything else. The beginnings of that passion lay in childhood for some, while others described how, step by step, they had become more and more involved. Bandura (Bandura 1982) said that personal life paths are shaped by chance encounters that may change people's interests and activities. Chawla (Chawla 1999) affirmed this finding in her study. She wrote about the participants: "As they took advantage of these opportunities, they developed new skills and beliefs, which sent them off in yet new directions, and so on. What may have first been chance became a foundation for continuities in attitudes and behavior, which determined responses to new chances" (p. 17). This interplay between interest, chance, and passion was also described by some of the individuals in the present study. To better distinguish and interpret the formative influences, future research in Madagascar should also include an assessment of the pro-environmental action and behaviour interviewees are involved in, as for example done by Palmer and colleagues (Palmer et al. 1998); this would help to assess individual levels of motivation and involvement (Palmer et al. 1998, Chawla 1998b).

Organizations did not figure prominently in Table 7.1 because of rigorous analysis (Tanner 1980, Palmer 1993). However, from the descriptions during the interviews it was obvious that some of the formative experiences would not have been possible without certain nongovernmental organizations, e.g., research field trips, or university collaborations with external researchers and NGOs. For some participants, the organizations offered the chance and opportunity to learn about Madagascar's biodiversity, to become interested in nature, and finally to become active for the environment. However, the fact of learning about local biodiversity, or participating in an environmental education programme alone does not

determine such trajectories (Richter et al. 2015). In this study, pupils who participated in an extensive environmental education comic book project by a German-Malagasy NGO were asked about career preferences. The results collected in rural primary schools of the Alaotra region did not show an increased choice of conservation as a career option by pupils who otherwise longed for academic professions such as teacher or doctor (Richter et al. 2015). One possible explanation is the lack of social acceptance of conservation bodies in some villages in that region (Rendigs et al. 2015).

7.5 Implications for education and conservation

The presented results are based on an exploratory research project with nine Malagasy participants. This number is not representative for the overall conservation and environmental education landscape in Madagascar, but aims to inform future studies with a more systematic approach, i.e., bigger sample size and both qualitative as well as quantitative methods. Future studies need to include participants with different educational background, economic situation, lifestyle, and culture, and consider a possible urban-rural divide. Furthermore, the multifactorial interplay of ecological, economic, and social conditions in Madagascar distinguishes this study from past research which focused mainly on western countries. It is hoped that this study will help the topic to receive attention in other developing countries as well.

At first glance, our results may suggest that the more education a child or adult receives, the higher the interest in the environment. On closer examination, however, not the (level of) education is the determinant factor, but the *content* of education. The (trans-)formative events were real life experiences. Ratsimbazafy (Ratsimbazafy 2003) specified that very few children knew about "what exists in their backyards (forests), and obviously when they grow up, they do not have an interest in getting involved in saving the endangered biodiversity"(p. 19). This seems to be confirmed by the current study; many participants did not learn about lemurs or biodiversity before university, and most did not place their interest in the environment in childhood. This may be explained by the lack of opportunity for most Malagasy to experience natural areas in private life. This poses a problem for conservation success especially in rural parts, where most pupils only attend primary school (UNDP 2015). As studies on environmental interventions and nature excursions showed, several-day excursions and hands-on

programmes can have a huge effect on participants' knowledge, interest, and attitude (Dettmann-Easler & Pease 1999, Volk & Cheak 2003, Hsu 2004). Our study showed that the university and research experience in nature can be a core element in the development of interest in the natural world. The findings suggest that there is not the one single way to environmental awareness, concern, or activism. (Chawla 1998b) noted that "one conclusive finding of research on responsible environmental behavior is that there is *no single all-potent experience* that produces environmentally informed and active citizens, but many together. This complexity may make the challenge of EE more difficult, but it also makes it more hopeful. Just as ecosystems are more resilient when they contain an abundance of species that can form diverse adaptations to change, so is the future more hopeful if diverse paths lead people into environmental commitments" (p. 19). Our study results suggest that intense multi-day stays in nature during young adulthood may already have strong transformative potential.

To conclude, we would like to share a statement from one of our study participants:

> "The most important experience is, well, to spend time in the forest. To see, to observe, to admire the beauty of nature."

7.6 Supplementary Material

Supplementary Material 7.1 Categories for sources of interest in the natural environment, with the respective definitions. Adopted from Chawla 1999 [5] and Palmer & Suggate 1996 [18].*

Category	Definition/ Examples
Education	Formal courses or settings.
Setting/field trip	Extracurricular activities such as field trips.
Persons	Inspiring teachers or educators.
Media	Influential books or authors.
Book or author	Magazines or educational journals.
Television	Television programs or documentaries.
Travel	Stays in foreign countries. Trips to distant regions in the country.
Organizations	Participation in outdoor, environmental, or social equity groups or associations.
Negative experiences	Destruction of a favorite natural place.
Habitat destruction	Decline or threat of a species or habitat.
Pollution, radiation	Observation or fear of environmental pollution or radiation.
Influence of friends	Influence of peers on choice of profession or field of study. Mediation of job opportunity or membership in environmental organization by friends. Team spirit.
Sense of social justice	Unfair treatment of people, especially the poor and vulnerable. Conviction that everyone should have access to a healthy environment. Experience of own or other people's poverty.
Family *Parents* *Others*	Pro-environmental values cultured by a family member. Environmental experiences led or shared with parents, grandparents, or others. Family role models in the areas of social justice or activism. Familial support for environmental efforts.
Experience of natural areas	Valued childhood places. Home or vacation surroundings such as forests, fields, lakes or mountains. Outdoor activities in natural

	environments, e.g. camping, hiking, bird watching. Adult stays in valued natural settings.
Concern for (grand) children	Aspiration to preserve a healthy environment for future generations.
Vocation	Job experiences that initiated or deepened environmental concern or commitment.
Principles or religion	Belief in holiness of nature, or the intrinsic right of its existence. Conviction that intact ecosystems are crucial. Environmental work as meaningful contribu-tion to a better world.

*The categorical system with definitions is based on Chawla 1999 [5]. The introduced additional (sub-) categories are shown in italics, and were adopted from Palmer & Suggate 1996 [18].

Chapter 8

Synopsis

This thesis focused on the exploration of environmental education (EE) and its potential to contribute to conservation on the basis of the case study region Lake Alaotra in Madagascar. Three research questions guided this applied research, each focusing on a crucial stakeholder group in the context of environmental education and conservation. This thesis aimed to investigate (i) whether local resource users in local communities are supportive for conservation (*Chapter 2 - 4*), (ii) whether teachers can realize EE in public primary schools, and which drivers and barriers exist to its implementation (*Chapter 5,6*), and (iii) what formative life experiences influenced Malagasy conservationists (*Chapter 7*). In this final chapter, the main findings are reflected upon in the deconstruction section, and then discussed in a broader context of conservation in the reconstruction section, thereby taking into account the implications of this thesis' findings.

8.1 Deconstruction, or 'the pieces of a puzzle'

The deconstruction of EE in the precedent chapters allowed for multidimensional insights regarding the situation of (environmental) education, including local people's awareness, knowledge and attitudes regarding aspects of the environment, conservation, and development. Each of the following subsections answers one of the three research questions of this thesis, while considering relevant literature.

8.1.1 The dichotomy of conservation

Natural resource users in the Alaotra region mostly accept and respect conservation values; however, the main importance for them is subsistence (*Chapters 3-6*), which is mostly based on agriculture and fishing (*Chapter 3,4*; Rakotoarisoa et al. 2015). This subsistence focus is reflected in attitudes toward land-types and different animals, which were dependent on their economic value or other obvious benefits, and is manifested in statements regarding marsh management options (*Chapter 3,4*). In other words, conservation is accepted as

long as it does not threaten local people's subsistence activities. Studies from other contexts suggest that perceptions toward protected areas or wildlife tend to be(come) negative when livelihoods are jeopardized (Oli et al. 1994, Hill 1998, Lee & Priston 2005, Hill & Webber 2010). Thus, the main reason for the neutral to positive attitudes this thesis identifies towards conservation values such as the special conservation zone Park Bandro and the locally endemic lemur species *Hapalemur alaotrensis* is likely that these do not interfere with livelihood interests. The finding that distance to Park Bandro is negatively correlated with awareness and knowledge of study participants (*Chapter 3,4*) is a phenomenon also encountered in other contexts (Brody et al. 2004, Urech et al. 2012). This may have implications for conservation, suggesting potentially increased attainment of several smaller priority conservation zones rather than few big ones (*Chapter 3*). The fact that fishers know more about the environment than other natural resource users despite lower educational levels (*Chapter 3,4*) proves that the environment is hardly addressed in primary schools in the region (*Chapter 2,5*,7). It moreover confirms that experience *in* the environment (cf. *Chapter 6*) increases knowledge, awareness and concern *about* the environment (*Chapter 3,4;* Tilbury 1992, Fien 1995).

Chapters 2-4 show the dichotomy of conservation in the Alaotra region; the marshes represent a cultural heritage to the local people, including the provision of construction material and medicinal plants, but the growing population's need for more rice is resulting in transformation of marsh land into rice paddies. At the same time, they also strongly depend on the (shrinking) lake for fisheries. Currently, conservation is still widely respected. However, with ongoing deterioration of agricultural and fishery outputs, and increasing population numbers, a 'tipping point' might be reached all too soon where most of local people's perceptions of conservation could change to the contrary, if they feel that conservation imposes overburdening restrictions on their livelihoods (*Chapter 4*; Ghimire 1994, Ormsby & Kaplin 2005, Kari & Korhonen-Kurki 2013 in Madagascar, but see also Parry & Campbell 1992 in Botswana or Fiallo & Jacobson 1995 in Ecuador). There is a need (and much potential) for improved communication on the part of conservation bodies about their work in the region to better clarify the tight linkages between conservation and system resilience. For example, unclarity exists for a majority of locals about the legal status, size and purpose of Park Bandro (*Chapter 3*). If the aims and reasons for conservation actions and restrictions remain unclear to a majority of the population, convincing

them to support conservation will become increasingly challenging with augmenting livelihood struggles. This is where education shows potential to function as a bridge between subsistence needs and conservation.

8.1.2 Challenges to the implementation of EE in primary schools

As for Madagascar, education in the Lake Alaotra region takes place mainly in primary schools. The assessment of school structure and organization of 18 Alaotra public primary schools revealed their critical situation; the schools usually suffer from overcrowded classes and a lack of professionally trained teachers (*Chapter 5*). Further logistical barriers (c.f. Ham & Sewing 1988) that apply to education in general exist, such as oftentimes outdated school equipment and material, a lack of funds (e.g., for excursions or educational material), and, as a fundamental barrier, pupils' malnutrition (*Chapter 5,6*). Chronic malnutrition is known to reduce learning performance and school success (Wachs 1995, Brown & Pollitt 1996, Arnold et al. 2007, Walker et al. 2007), thus representing a critical barrier to learning on a pupil level. National and international reports suggest that the situation of public primary schools is similarly precarious in most rural public primary schools in the country (e.g., UNDP 2015, EPDC 2016). To some extent, the current struggles to provide (quality) 'education for all' might be attributed to the period of *malgachisation* (1972-1992), which caused a deterioration of quality in public schooling (*Chapter 5*; Johnson 2006, Randrianja & Ellis 2009). Another reason is the recurrent political instability of the country and resulting weakness in governance (Randrianja 2012b).

This also manifests on the teacher level, where educational barriers such as a lack of mandatory pre-service teacher trainings results in limited methodological expertise (*Chapter 5,6*). The dominant teaching approach in the region and beyond is banking education, which does not allow stimulation of critical thinking (*Chapter 5*, Freire 1970, Breunig 2005, Dolins et al. 2010). Rather, the school system may propagate superficial 'knowledge' of what *not* to do, i.e. reducing EE content to prohibition messages (Richter et al. 2015). This is a missed opportunity for both conservation and (sustainable) development because people may only see the restrictions on their livelihoods, but may not understand the possible linkages and feedback loops on their own livelihoods. For EE specifically, there were no official trainings addressing EE content, which resulted in little knowledge and general understanding of EE topics (*Chapter 5*), despite high awareness levels about where EE could benefit society (*Chapter 6*). A lack of environmental

awareness and knowledge lowers chances for effective EE (van Petegem et al. 2007). This lack of EE expertise has been attributed to a lack of adequate teacher trainings (Mosothwane 1991, Pe'er et al. 2007), which should address both subject matter content and pedagogical content knowledge (Kim & Fortner 2006). In this thesis, teachers acknowledged the existence of a multitude of environmental problems reflecting their awareness and knowledge, but most demonstrated interest in the consequences on humans, such as health or agricultural issues, rather than in the causality of environmental problems (*Chapter 5,6*).

Attitudinal barriers were also identified: EE ranks low as being critical in after-school life compared to most school subjects, and subsistence was judged more important than conservation (*Chapter 5*). For teachers, there is a trade-off situation between negative environmental impacts versus an improved social condition (e.g., example of the invasive fish species shown in *Chapter 5*). Herewith, teachers' attitudes are congruent with the 'average' natural resource users, who favor subsistence over conservation values (*Chapter 3,4*).

Similar barriers have been identified in other settings; besides time, Ham & Sewing (1988) identified lack of instructional material and funding, and the teachers' lack of knowledge and natural science background as major factors. Since then, many studies have addressed barriers facing the implementation of EE (Ham et al. 1988, Simmons 1998, Kollmuss & Agyeman 2002, Moore 2005, Chawla & Cushing 2007, Hashemzadeh 2016) and have identified further obstacles such as a lack of pre- and in-service EE training, insufficient support from school principals and from the community, and transportation or safety issues, to name but a few. Despite many years of research and advances in the field, barriers still persist in formal education settings (Kollmuss & Agyeman 2002, Moore 2005, Chawla & Cushing 2007). Teacher trainings have been proposed to address some of the main barriers (Kim & Fortner 2006, Kimaryo 2011, Hashemzadeh 2016). In the Alaotra, EE for teachers represents an anthropocentric concept, while NGOs from abroad follow largely eco-centric ideas (*Chapter 2,5*), indicating that education for sustainable development (ESD) might be a more suitable approach to include and address locals' subsistence needs more explicitly (*Chapter 5*). The inclusion of teachers' concerns for subsistence and livelihood aspects into EE projects may increase the actual ownership of such programs and may represent a potential driver to overcome attitudinal barriers.

In sum, the exploration of the school system's structure and organization, its history, teachers' education, knowledge, and perceptions about EE and the environment provides a multitude of insights about the education of tomorrow's resource users (*Chapter 5,6*). The results of this thesis suggest that EE, as envisioned by global policy guidelines of UNESCO, is currently not implemented in the Alaotra public primary schools. It thus remains questionable whether a lake-wide implementation of EE into public primary schools under the current structural and institutional conditions would be possible at all. A majority of teachers would need intense training on environmental and ecological issues, including methodological trainings. Here, (an improvement of) the cascade training system in place could act as a crucial driver for educational change (cf. Hayes 2000). However, as discussed in *Chapter 5*, in order to ensure that such programs will be locally meaningful and useful, teachers need to be involved in the development of educational material to ensure (i) inclusion of local needs and values, and (ii) meeting teachers' capacities and further developing them through active participation. Given the perceptions and attitudes of both natural resource users (*Chapter 3,4*) as well as local teachers (*Chapter 5,6*), it is important to include developmental concerns into conservation planning (*Chapter 2*).

While the theoretical framework 'education *about*, *in*, and *for* the environment' (Lucas 1972, Palmer 1998) may be suitable to professionalize EE in Madagascar (*Chapter 6*) and to overcome some of the barriers to EE, there are further research paradigms worth considering, which look at conservation and education from a resource management and resilience perspective. One such example is Sterling (2010), who suggests a new paradigm of 'sustainable education' to reach resilience by facilitating critical thinking skills in learners (*Chapter 6*, Sterling 2010). Such theoretical frameworks can help reduce the gap between research and practice, i.e., to use new insights for efficient 'tools of change'. These can act as drivers to 'reconstruct' EE in Madagascar.

8.1.3 Higher education offers transformative experiences

Interviews with Malagasy conservationists and environmental educators suggest that opportunities and experiences during higher education are the main stimulus for developing an interest in the natural environment and its conservation (*Chapter 7*). More specifically, the factors that were judged to be meaningful are

field trips as well as contact and exchange with inspiring educators, many from abroad. Experience in nature has often been found to leave a lasting impression and impact on individuals by fostering positive attitudes toward nature (Tanner 1980, Palmer & Suggate 1996, Chawla 1999, Chawla & Cushing 2007). What is different in the present study is that the experiences took place relatively late as compared to in other literature where study participants mainly referred to childhood experiences (ibid). This may relate to the fact that the environment is not widely taught in school (*Chapters 3-6*) and that most Malagasy children do not get the chance to have real-life experiences of forest or lemurs (Ratsimbazafy 2003). Confirming this, some participants mentioned that they did not learn about lemurs before their studies at university (*Chapter 7*). If only higher education raises awareness and concern about conservation needs, this poses a problem for conservation success especially in rural parts of Madagascar, where most pupils only attend primary school. However, it is worth noting that education *in* the environment also raised knowledge and concern of many fishers at Lake Alaotra (*Chapter 3,4*), even if these experiences did not take place in formal settings. The question remains whether these experiences and resulting positive attitudes are introduced to society or not. As for the active conservationists, society and family were rather unsupportive of their pursuit of a conservation career, with their pro-conservation perspective largely fostered by educators who offered external perspectives to the learners, e.g., foreign researchers or their Malagasy colleagues and partners at university (*Chapter 7*). In contrast, international literature reported that family was a main component for developing positive attitudes towards the environment (Chawla 1999). In Madagascar however, society largely regards the environment as something 'sinister' because it is inhabited by (mostly evil) spirits, with ancestral rules (*fady*) determining daily behavior (Golden 2014). This reveals an additional dimension of environmental perceptions that did not emerge during the inquiries of *Chapters 2-6*, but still plays a major role in Malagasy every-day life (Golden 2014). This further accentuates the gap between the different values represented by conservation organizations and local value systems. The descriptions of the study participants in *Chapter 7* suggest that their choice of conservation was most likely possible because their economic status allowed them to make a choice, i.e., because they did not directly depend on subsistence agriculture or natural resource use. Other studies confirm that people from urban areas and/or with higher income levels are more supportive of conservation or concerned about environmental issues than rural, poorer people (Eden 1993, Yilmaz et al. 2004). In the case of the conservationists of the present

thesis, they are an (educational) elite in Madagascar and their higher education level offered them access to new experiences, worldviews and opportunities, which in turn shaped their interests and thus influenced their livelihood path. This reflects the interplay between interest, chance encounters, and passion which influence individual life courses (Bandura 1982, Chawla 1999). These results beg the question whether and how education in rural public primary schools can contribute to a reconciliation of conservation and development in the Lake Alaotra region and elsewhere in Madagascar.

8.2 Reconstruction of EE in Madagascar

Taking stock of the identified and contextualized drivers and barriers to EE thus far, a fundamental question deserves scrutiny: Does EE have the potential to contribute to improved conservation outcomes in Madagascar? Considering this question implies taking into account the context in which conservation in the country takes place. Madagascar is an agrarian country with a very poor and largely under-educated population (UNDP 2015). Much of the conservation efforts in Madagascar focus on the protected area system. Since 2003, almost 100 new protected areas (PAs) have been established to triple the PA coverage in Madagascar under the Durban vision (Gardner et al. 2013). While the first 46 PAs were strictly protected sites for biodiversity conservation (including research and recreation; Randrianandianina et al. 2003), the new sites are intended to serve multiple purposes, including sustainable use and extraction of natural resources to support poverty alleviation and development. These multi-use PAs are co-managed by non-governmental organizations (NGOs) and local communities (Gardner 2011, Gardner et al. 2013). However according to the literature, it appears that both NGOs and communities are largely overburdened or unprepared to implement these complex management tasks (Gardner 2014, Scales 2014a and references therein; these provide in-depth considerations and discussions on benefits and constraints of former and current conservation practices of and with communities, as well as limitations and vantages of these approaches, e.g., Pollini et al. 2014). In this context, Gardner et al. (2013) suggested that land-use practices in Madagascar will definitely change at some point in time. In a first scenario they postulated that innovation might occur when resource users must adapt as a response to resource exhaustion, while in a second scenario, the conservation community could support the transition to

more sustainable practices *before* natural resources run out. Reconsidering that Madagascar is a global conservation priority (Brooks et al. 2006), all available financial, technical, human, and institutional resources (just to mention a few) need to be allocated and united to support the ultimate goal of sustainable development in the sense of using only as much resources as the ecosystem can reproduce. This knowledge and corresponding skills need to flow into educational programs and other learning opportunities.

Evidence shows that conservation can hardly be successful if the needs of locals depending on the ecosystems are ignored (Agrawal & Gibson 1999, Salafsky & Wollenberg 2000, Mace 2014). Particularly in the fields of conservation and sustainable development, it has become increasingly accepted that interdisciplinary approaches are needed in the search for solutions (Fisher & Christopher 2007). Changes have occurred in the way ecological systems are seen, and today they are perceived as being interlinked with socio-ecological conditions (Krasny et al. 2010). In this context, the role of education evolved into being a preparation to be able to cope with future change and uncertainty. Muttarak & Lutz (2014) reviewed evidence from different contexts that suggested that education is key to reducing people's vulnerability to natural disasters and climate change. Sterling´s (2010) resilience-based concept of 'sustainable education' took this a step further: he proposed a new educational paradigm to consolidate EE, sustainability and natural resource management for resilient socio-ecological systems. He suggested a reconciliation of the two 'hostile' paradigms of the "instrumental" and "intrinsic" views of education; the instrumental, also called behaviorist paradigm targets external outcomes such as changes in awareness, knowledge, attitudes and values, mostly through transmission of content, whereas the intrinsic view focuses on experiences and processes of learning and teaching, thereby aiming to develop critical thinking in learners to enable and ultimately empower them to make informed decisions. Sterling (2010) argues that both approaches are needed to ensure resilience of socio-ecological systems, i.e., to enable humans to respond wisely and flexibly to unpredictable change.

The present thesis suggests that educational interventions of NGOs in Madagascar mostly relate to the behaviorist paradigm of education (cf. Robottom & Hart 1995, Sterling 2010). This is comprehensible given the urgency of environmental problems requiring immediate response. Many NGOs aim to achieve conservation outcomes through forming positive attitudes towards wildlife and nature conservation by integrating EE in collaborating schools. However, they are

structurally limited by (i) the number of schools they can reach out to; (ii) financial constraints; (iii) understaffing (just to mention the most obvious ones). Moreover, many EE interventions by NGOs are not systematically documented, which makes it almost impossible to judge whether such interventions have an impact. It has therefore been widely assumed that nation-wide inclusion of EE into the school curriculum could offer a better coverage of EE in primary schools. However, the results of this thesis suggest that the school system is unprepared to shoulder such responsibilities when being faced with issues surrounding meeting basic needs. Sporadic trainings of primary school teachers are not sufficient to allow a change in the educational system towards critical thinking. Haigh (2006) suggested that EE should be disseminated into the community through lifelong learning processes instead of being restricted to formal learning. This is especially important in contexts such as Madagascar where most natural resource users spend a maximum of five years at school (UNDP 2015). Informal EE can thus offer an alternative, for example via the involvement of stakeholders in environmental action with NGOs (Haigh 2006). Still, it is suggested that NGOs could represent a crucial stakeholder in supporting the Malagasy school system, having the outreach and human resources, i.e., the teachers, to allow for broad coverage of EE in children's basic education.

Taking a step back and reconsidering the three stakeholder groups examined in this thesis (resource users, teachers, conservationists) in the context of sustainable development allows a glance at its core principles. The concept of sustainable development supposes that environmental, social, and economic development need to be equally addressed to reach sustainability (IUCN 1980, WCED 1987). Sustainability can be seen as a three-legged chair that will fall over if any of the legs are too short. The three stakeholder groups can be considered as proxy for the three pillars of sustainable development, namely economy (broadly speaking in the sense of poverty eradication), society (education), and the environment (including its protection): (i) the local resource users represent economy with a main interest in subsistence improvement; (ii) teachers share similar attitudes and values, but additionally incorporate social issues such as hygiene and health. They are concerned about the situation in their schools and villages, while educating the future resource users, thus representing the social component in the system. (iii) On the other end of the human-nature relationship range are the conservationists; their main concern largely lies in the preservation of the natural world and the measures that are needed to reach that goal. From a

sustainable development perspective, all three components are needed for the socio-ecological system to be balanced.

Considering a 'co-construction of shared futures', the international literature offers a multitude of insights about different inter- and transdisciplinary approaches that could inform and improve (EE) approaches in the country. A promising approach is social learning (Sterling 2010), which could also help in Madagascar to increase efficiency of protected area management in the context of conservation (Gardner 2012). Social learning is defined as collaborative or mutual learning in multi-stakeholder settings (Armitage et al. 2008). It allows exchanging knowledge and experiences, building local capacity, and interacting learning networks, which can instill adaptive management capacities in the long run (Folke et al. 2002, Armitage et al. 2008, Berkes 2009).

Such social learning scenarios may also be incorporated into schools as a learning approach that could address a multitude of topics referring to local realities. This approach would suit the Malagasy oral culture (Coser 1992, Cole 1997) and does not require costly material. Sterling writes that "The paradox of education is that it is seen as a preparation for the future, but it grows out of the past. In stable conditions, this socialization and replication function of education is sufficient: in volatile conditions where there is an increasingly shared sense (as well as numerous reports indicating) that the future will not be anything like a linear extension of the past, it sets boundaries and barriers to innovation, creativity, and experimentation" (Sterling 2010: 520). Social learning seems to be the most likely answer to developing increased awareness, knowledge and skills towards a more sustainable future. If EE scholars manage to promote the integration of social learning or similar concepts into educational programs, then EE may well contribute to improved outcomes of conservation and development.

8.3 Final remarks

The deconstruction and reconstruction of EE in this thesis, and the consideration of EE's potential contribution to conservation in Madagascar suggest the need for a transformative educational approach, which could support a development towards sustainable and resilient socio-ecological systems in Madagascar. The following sections briefly review the strengths and weaknesses of this thesis, and give recommendations for future research and action.

8.3.1 Strengths and limitations of this thesis

The strength of this thesis lies in the inter- and transdisciplinary approach, which allowed consideration of multiple dimensions of the socio-ecological system of Lake Alaotra. The consideration of different stakeholders allowed an in-depth understanding of the condition and potential of EE in the Lake Alaotra region while using measures enhancing the trustworthiness of the data and its interpretation.

The chosen research approach also implied a number of limitations:

- The case study approach lead to results that are mainly descriptive and not necessarily transferrable to other regions in Madagascar, even if personal communications with practitioners and other researchers suggest similar conditions in other regions.

- The number of interviewed teachers was restricted due to the qualitative approach, but triangulation measures (e.g., focus groups, participatory workshops, grey literature, expert consultation) ensured credibility and robustness of the research data.

- This thesis focused on only three stakeholder groups; the pupil level for example was not considered at all, despite the fact that they are 'tomorrow's resource users' and that EE interventions mainly focus on them. However, the chosen groups are a suitable representation of the main groups involved in conservation.

Furthermore, a number of topics emerged during the research for this thesis that are worth further examination, to contribute to EE and conservation:

- Status quo and teacher capacity in *private* primary schools
- Perceptions on conservation values and livelihood issues of natural resource users both at Lake Alaotra and in other regions of Madagascar
- Situation of (environmental) education in other administrative districts
- Scientific evaluation of EE programs and interventions run by NGOs in other regions of Madagascar
- Significant life experiences of conservationists from rural parts as opposed to the largely urban sample in this thesis

The suggested research would further increase understanding of the conditions of EE and conservation in Madagascar, thus contributing to the provision of the best possible evidence to inform policy and improve practice.

8.3.2 Outlook

This thesis is the first scientific examination of the anticipated inclusion of EE in the school system in Madagascar and EE's potential to support conservation in the country, with the Lake Alaotra case study as a baseline for future research. There is no prior peer-reviewed record available and this thesis thus adds a "Madagascar voice" to the international literature of EE. The following list contains a brief outlook on how the Alaotra region could enable a change in the trajectory of education by facilitating the adoption of EE and efforts to make it more meaningful for conservation and sustainable development (EE here stands for any approach related to conservation and sustainability education capable of promoting critical thinking skills and adaptive capacity in learners):

- Education *about* the environment with the support of updated textbooks (relevant environmental issues, reasons for conservation, and suggestions for critical examinations and participatory approaches)
- Education *in* and *for* the environment with the support of NGOs (allocation of funding, provision of expertise, and monitoring of EE efforts and outcomes)
- Pre- and in-service teacher trainings to ensure quality environmental education (teacher professional development programs established by the Ministry of Education and the Ministry of Environment, Ecology, and Forests and other relevant authorities; including content knowledge regarding environmental topics and sustainability; pedagogical content knowledge including participatory and student-centered approaches (but also skills to create and adapt material that is relevant to the local context); inclusion of EE topics into exams; the cascade training system; and monitoring by school boards)
- NGO capacity building and exchange (EE expertise, approaches, materials, systematic impact monitoring)
- Increased donor support for EE and its evaluation to facilitate context-specific evidence about best practice and failures (to avoid the long-term implementation of merely assumption-driven EE interventions)
- Creation of regional networks for social learning including school staff, NGOs and researchers, but also natural resource users (identifying (educational) needs of resource users; develop, test, improve and exchange EE material; conservation rules awareness raising, etc.

- Improved researcher-practitioner collaboration and exchange; local networks may be a potential focal point to inform researchers about (interdisciplinary and applied) research needs
- Long-term collaborations between schools, NGOs and universities (both Malagasy and foreign) to stimulate implementation and constantly enhance practice of context-specific EE

In sum, both, the region around Lake Alaotra and the country need educational approaches that develop adaptive capacity and prepare resource users to respond to anticipated threats, especially given the vulnerability of the rural poor due to overexploitation and climate change (Hannah et al. 2008, Shepherd et al. 2013). The previous paragraph provided some suggestions and recommendations as to how to improve EE's contribution to conservation and development. It herewith endorses former calls in the Madagascar-specific literature that more conversations and exchanges are needed within and between researcher and practitioner communities to develop best practice (Ganzhorn 2010, Gardner 2012, Scales 2014b, Reibelt & Nowack 2015). This applies both to (environmental) education and conservation.

Chances of success largely depend on the ability of the Malagasy government to demonstrate readiness and commitment to improve the educational situation, so as to enhance the international community's readiness to support the Malagasy government and key organizations in the education, conservation, and development sector (this may include the renewal and intensification of state collaboration with for example Unicef and the World Bank, which supported the school system with material donations and financial aid before the 'political crisis'). It will moreover be crucial to monitor and evaluate the efficacy of different approaches as millions of dollars have already been invested in the educational system without producing the expected results (Waeber et al. 2016). As noted above, collaborations with national and foreign universities can attract researchers interested in contributing solutions and improved understanding through applied research.

With the closing of this thesis, promising activities and collaborations are on the way in Madagascar. The Ministry of Education has endorsed the concept of Education for Sustainable Development to be integrated in the national school curriculum and the World Bank, IDA (International Development Association) and GPE (Global Partnership for Education) recently assured 55 million dollars for

improving preschool and basic education in Madagascar. With the framework finally set on the political level, the future will provide evidence as to whether further steps are taken to overcome the state of mere 'official integration' and reach real implementation, so that EE can contribute to a better future for both humans and biodiversity. The results of this thesis may serve to accompany these processes by providing a compendium of evidence from the Alaotra.

8.4 Conclusions

According to international policy frameworks, EE holds a key role in enabling sustainable development. However, poverty poses additional challenges to fighting overexploitation, nature degradation, and biodiversity loss. In Madagascar, non-governmental organizations mostly implement EE programs to improve success of their conservation activities. To increase EE coverage, the aim to include EE into teaching still seems to be the best option to reach the majority of children, with public primary schools being the only formal education for most rural resource users. However, the results of this thesis suggest that a multitude of barriers exist to the implementation of EE in public primary schools. Moreover, local people including teachers favor subsistence over conservation, suggesting the need to integrate this component into teaching as well. If EE is to contribute to a reconciliation of conservation and development, time, long-term commitment, increased funds and concerted efforts of a multitude of different stakeholders are required. NGOs are in a good position to act as mediators between funding agencies, government agencies, and the local communities to facilitate the inclusion of EE in formal and informal education. However, while the contribution of NGOs' technical knowhow, opportunities to attract donors, and provision of capacity building could offer critical contributions, the long-term goal should be 'sustainability' and 'resilience' of the educational system itself, without depending on external funding and 'courtesy'.

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